NASA CONTRACTOR REPORT 166442 - Vol. 2

ADVANCED PREDICTION TECHNIQUE FOR THE LOW
SPEED AERODYNAMICS OF V/STOL AIRCRAFT, VOL. II

(NASA-CR-166442-Vol-2) ADVANCED PREDICTION TECHNIQUE FOR THE LOW SPEED AERODYNAMICS OF V/STOL AIRCRAFT. VOLUME 2: USER'S MANUAL Final Report, Mar. 1982 - Mar. 1983 (Vought Corp., Dallas, Tex.) 127 p HC A07/MF A01 G3/02

N84-26663

Unclas
13929

D. Beatty and M. K. Worthey

CONTRACT NAS2- 11156
March 1983

NASA

NASA CONTRACTOR REPORT 166442

ADVANCED PREDICTION TECHNIQUE FOR THE LOW SPEED AERODYNAMICS OF V/STOL AIRCRAFT, VOL. II

T. D. Beatty

Vought Corporation
P. O. Box 225907
Dallas, TX 75265

Prepared for
Ames Research Center
under Contract NAS2-11156

NASA
National Aeronautics and
Space Administration

Ames Research Center
Moffett Field, California 94035

FOREWORD

A study was conducted for the NASA AMES Research Center by the Vought Corporation to develop improved methodologies for predicting the propulsive induced aerodynamics of V/STOL aircraft in Transition/STOL flight. The study was performed under NASA Contract NAS 2-11156 with Mr. Richard Christiansen of NASA AMES as contract monitor. The Vought efforts in this program were accomplished under the direction of Mr. T. D. Beatty who was the Principal Investigator for this contract. He was assisted on the contract by Mr. M. K. Worthey. Both personnel are from the Flight Technologies directorate of the Vought Corporation.

The authors are particularly indebted to Mrs. D. L. Lewis and Mr. J. W. McCharen for their support in the programming of the computer code.

This report consists of two volumes. The technical discussion of the methodology, verification of the techniques and conclusions and recommendations are presented in Volume I. Volume II is a detailed user's manual for the computer code developed.

TABLE OF CONTENTS

SECTION		PAGE

1.0 INTRODUCTION AND SUMMARY

The capability of predicting the propulsive induced forces and moments on a V/STOL aircraft in the transition or STOL region of flight is very important to the aircraft designer. These effects will strongly influence the location of the jet nozzles and possibly the required thrust of the engines. The Vought V/STOL aircraft propulsive effects (VAPE) program described in this report is a computerized method for calculating these propulsive induced effects.

Volume I of this report describes the technical approach and Volume II is a description of the data input to the computer code, and the code itself.

The VAPE program is a single integrated modular computer program for the prediction of propulsive induced effects. This rather large computer program (over 190 subroutines) consists of four basic components: (1) nacelle inlet analysis module, (2) three dimensional lifting potential flow module with viscous effects, (3) three jet modules, and (4) a nacelle force and moment module. The transmission of data from one component to another is automatic with little or no handwork involved. However, the ability to save results for a multi-step analysis is also provided.

In normal usage the body geometry is input to the HESS three dimensional potential flow program and the nacelle geometry is input to the inlet analysis method. The velocities on the inlet face as predicted by the inlet analysis code are then transferred to the HESS program as boundary conditions on the inlet face. The HESS program then accesses one of the jet methods to obtain the influence velocities due to the jets. The HESS program is then run to completion to obtain the flow field about the vehicle.

The basic framework of the VAPE program is given in Figure 1-1. The program consists of a small executive program that controls the activities of the other program components. Each of the major components of the VAPE program is actually a complete program in itself. They have been combined with the use of the executive main program to give one new and rather large program. The discussions throughout this manual will frequently use the term "program" in a rather loose sense when referring to any one of the major components.

Each of the major program components except the inlet force and moment module can be used as though they are stand-alone programs with all data input at the time of execution. The programs are also capable of saving data in forms required by the various other programs. By use of appropriate data-unit definition cards, any of these data sets can be saved between machine runs. This increases the flexibility of the system and permits the user, for example, to examine the printed output from one program before continuing execution.

The amount of output produced by each program component depends upon the options selected by the user. The print control flags in each component should be selected carefully to avoid massive amounts of unwanted output.

The amount of machine time (both CPU and IO times) will also vary with the options selected. Also, each computer installation has its own algorithm for calculating the CPU and IO times. The user will, therefore, have to run several jobs using the different program options to determine the typical solution times for his particular installation. In general, the times for the potential flow and boundary layer programs in the inlet analysis routine will be relatively short, and the HESS 3-D program much longer.

In summary, a computerized prediction method for propulsive induced forces and moments in transition and short takeoff and landing (STOL) flight is presented. The method developed was based on the Vought V/STOL aircraft propulsive effects computer program (VAPE).

The VAPE program is capable of evaluating:

- Effects of relative wind about an aircraft
- Effects of propulsive lift jet entrainment and flow blockage
- Effects of engine inlet suction on the aircraft flow field
- Viscous effects on lifting surfaces
- Determination of engine inlet forces and moments including inlet separation prediction capability

The effects of relative wind about an aircraft with or without jets and/or inlet effects is determined by a very general three-dimensional panel method.

The effects of the propulsive lift jets are determined by one of three different jet models which have been extensively modified and/or developed at Vought. Some of the major modifications made to the jet models at Vought include:

- Intermediate ground effects calculations
- Calculations of the flow field in the STOL region of flight

The effects of engine inlet suction on the aircraft is determined by a NASA Lewis code for axisymmetric inlets which has been modified and automated at Vought. This method will determine the pressures on the inlet face and nacelle inlet lips. The VAPE program will then utilize these pressures to determine the ram drag and forces acting on the inlet. Calculations may also be done to determine when and where separation occurs on the inlet lip.

The various options of the VAPE program have been verified by comparisons between calculated and experimental values.

A computer program code was delivered to NASA and made operational on the NASA CDC 7600 computer. A technical manual for this program is contained in Volume I of this report.

2.0 INPUT INSTRUCTIONS

The VAPE program requires one primary control card followed by the required sets of data cards for each program option to be executed. The sets of data furnished must be in the order as specified by the option number on the primary control card.

The general scheme used in describing the input data is shown below:

Colume	Code	Routine Format	Explanation

Column - Column indicates the starting position on the card for each data field.

Code - The "code" gives the FORTRAN name used in the read statement by the program.

Routine - "Routine" indicates the subroutine where the data in read.

Format - The parameter "FORMAT" which is given right under the routine name, indicates the FORTRAN format of the data read statement field. The parameter I5 would indicate that the parameter is an integer in a field that is 5 columns wide. Integers should be punched on the right side of the field (right justified). The parameter F10.0 would indicate a floating point number punched with a decimal point i.e., -12.354). The number may be punched anywhere in the field indicated irrespective of the decimal point location indicated by the format. The parameter E12.6 would indicate a floating point number punched with a decimal point i.e., 5.0×10^6). On input E and F formats are treated identically.

Free format indicates that no format is used. Data is input separated by one or more blanks, a comma, or a slash. Embedded blanks are not permitted.

Explanation - The description of the input data is given under "explanation".

2.1 DATA STORAGE

In order for the VAPE program to function efficiently, a large amount of data must be transferred between subprograms. Some of this data is only temporary and is stored on "scratch" files which are not retained when no longer needed. Certain data which is required by various routines is stored on permanent files which can be saved, so that the program can be interrupted and then restarted. Table 2.1-1 lists the file names, and a short description of the file contents. Table 2.1-2 presents a summary of the files used by file number.

Table 2.1-1
Data Storage Files

ORIGINAL PAGE IS OF POOR QUALITY

FILE UNIT	FILE CREATED IN SUBROUTINE	FILE ALIAS	FILE USED IN SUBROUTINE	FILE ALIAS	DESCRIPTION
MT1	EOD		LOCAL*	IFUTAP	SCRATCH FILE
	BSETUP	IRSIDE	SOLMOR	DEVTAP	RHS COLUMN
MT2	EOD		LOCAL*		SCRATCH FILE
	COMBYN		LOCAL*		SCRATCH FILE
	BSETUP		INP2		BOUNDARY LAYER STRIP INFORMATION
	SOLMOR	NOUT	LOCAL		SCRATCH FILE
	HESS		LOCAL		SCRATCH FILE
MT3	EOD		LOCAL*		SCRATCH FILE
	COMBYN		LOCAL*		SCRATCH FILE
	VCOM	NOUT	AFORM	NOUT	ONSET FLOW MATRIX
			OLCMFLO	NOUT	
MT4	EOD		LOCAL		SCRATCH FILE
	LIFT		VFMLFT		GEOMETRY DATA
	NOLIFT		VFMNLF	NTT	
	COLSOL	NW,NSIG	PKUTTA		
			OLCMFLO		SIGMA MATRIX
			HESS		
MT5					INPUT
MT6					OUTPUT
MT7	SOLMOR	NSI	LOCAL		SCRATCH FILE
MT8	EOD		LOCAL*		SCRATCH FILE
	COMBYN		LOCAL*		SCRATCH FILE
	VFMLFT	N8	VFMLFT	N8	VELOCITY MATRIX
	VCOM	IONSET	PKUTTA	IONSET	KUTTA MATRIX
MT9	EOD		LOCAL*		SCRATCH FILE
	COMBYN		LOCAL*		SCRATCH FILE
	AFORM	NAIJ	COLSOL	NIN	AIJ MATRIX
MT10	EOD		LOCAL*		SCRATCH FILE
	COMBYN		LOCAL*		scratch file
	AFORM	NRSIDE	COLSOL	RHSTAP	RIGHT HAND SIDE MATRIX
MT11	EOD		LOCAL*		SCRATCH FILE
	VFMNLF		VCOM		

ORIGINAL PAGE IS
OF POOR QUALITY

Data Storage Files (Continued)

FILE UNIT	FILE CREATED IN SUBROUTINE	FILE ALIAS	FILE USED IN SUBROUTINE	FILE ALIAS	DESCRIPTION
			AFORM OLCMFLO	NT NT	SOURCE VELOCITY MATRIX
MT12	EOD		LOCAL*		SCRATCH FILE
	VCOM	MT19	JETOLD		
	JET3	MT19			JET DATA
	JET3IN	MT19			
MT13	EOD		LOCAL*		SCRATCH FILE
	VFMLFT	ND	VCOM	ND	DIPOLES VELOCITY
	COLSOL	NOUT	LOCAL		SCRATCH FILE
MT14	HINIT		INPUT VCOM INLENT JETOLD RECJET JET3IN		REGENERATED INPUT
	COLSOL	NS1	LOCAL		SCRATCH FILE
	SOLMOR	NS1	LOCAL		SCRATCH FILE
MT15	COLSOL	NLTAPE	SOLMOR	NLTAPE	L-MATRIX
MT16	COLSOL	NTTAPE	SOLMOR	NTTAPE	T-MATRIX
MT17	EOD		COMBYN		GEOMETRY DATA
	VFMNLT		PKUTTA	DVIJ	KUTTA RIGHT SIDE
	VFMLFT				
MT18	SOLMOR	NW	HESS	NBLSOL	ADDITIONAL SIGMA FROM SOLMOR
MT19					SAME AS MT12
MT20	SCIRCL		EOD		INPUT
	GEOMOD		EOD		INPUT
	INPUT				OUTPUT OPTION
MT21	VCOM				OUTPUT OPTION
	JETOLD JET3IN				

ORIGINAL PAGE IS
OF POOR QUALITY

Data Storage Files (Continued)

FILE UNIT	FILE CREATED IN SUBROUTINE	FILE ALIAS	FILE USED IN SUBROUTINE	FILE ALIAS	DESCRIPTION
MT22	COMBYN COMFLO		LOCAL* LOCAL		SCRATCH FILE SCRATCH FILE
MT23	COMBYN		LOCAL*		SCRATCH FILE
MT25	COMBYN		TRANSG		TRANSFORMED COORDINATE DATA FROM COMB
MT26	TRANSG		VISCUS		TRANSLATED, SCALED COORDINATE DATA FROM TRAN
MT27	VISCUS		GEOMOD		DT DATA FROM VISCUS
MT28	SCIRCL		GEOMOD		X, Y, ALPHA DATA FROM SCIRCL
MT29	GEOMOD		EOD		BUILT FOR EOD PASS 2
MT34	COMBYN		INLINT		
MT37					MASS STORAGE
MT39	HINIT		BSETUP		BOUNDARY LAYER INPUT
MT40					MASS STORAGE
					NOTE: *-May be located in more than one routine but member of major group.

Total No. of tape units	34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	LOGICAL TAPE UNIT
(4)	I	I	I	I	I	I	*	I	I	I	I	I	I	I	*	I	I	I	I	I	I	I	I	I	I	I	I	I	*	*	I	I	I	I	SCIRCL
(16)	I	I	I	I	I	*	*	I	I	I	I	I	I	I	*	I	I	*	I	I	I	*	*	*	*	*	*	I	*	*	*	*	*	*	EOD
(15)	*	I	I	I	I	*	*	I	I	*	I	*	*	I	*	I	I	*	I	I	I	I	I	I	*	*	*	I	*	*	I	*	*	I	COMBYN
(8)	*	I	I	I	I	*	*	I	*	*	I	I	I	I	*	I	I	I	I	I	I	I	I	I	I	I	I	I	*	*	I	I	I	I	TRANSG
(9)	*	I	I	*	I	*	*	*	*	I	I	I	I	I	*	I	I	I	I	I	I	I	I	I	I	I	I	I	*	*	I	I	I	I	VISCUS
(8)	*	I	I	I	I	*	*	*	I	I	I	I	I	I	*	I	I	I	I	I	I	I	I	I	*	I	I	I	*	*	I	I	I	I	GEOMOD
(5)	*	I	I	I	I	I	I	I	I	I	I	I	I	*	*	I	I	I	I	I	*	I	I	I	I	I	I	I	*	*	I	I	I	I	HESS:HINIT
(5)	*	I	I	I	I	I	I	I	I	I	I	I	I	*	*	I	I	I	I	I	*	I	I	I	I	I	I	I	*	*	I	I	I	I	HESS:HINIT:LSTINP
(6)	*	I	I	I	I	I	I	I	I	I	I	I	I	*	*	I	I	I	I	I	*	I	I	I	I	I	I	I	*	*	*	I	I	I	HESS:INPUT
(10)	*	I	I	I	I	I	I	I	I	I	I	I	I	*	I	I	I	*	I	I	*	*	I	*	I	I	*	I	*	*	*	I	I	I	HESS:VFORM
(10)	*	I	I	I	I	I	I	I	I	I	I	I	I	*	I	I	I	*	I	I	*	*	I	*	I	I	*	I	*	*	*	I	I	I	HESS:VFORM:VFMHLF
(10)	*	I	I	I	I	I	I	I	I	I	I	I	I	*	I	I	I	*	I	I	*	*	I	*	I	I	*	I	*	*	*	I	I	I	HESS:VFORM:VFMLFT
(12)	*	I	I	I	I	I	I	I	I	I	I	I	I	*	I	*	I	*	I	I	*	*	*	*	I	I	*	I	*	*	I	I	I	I	HESS:VCOM
(12)	*	I	I	I	I	I	I	I	I	I	I	I	I	*	I	*	I	*	I	I	*	*	*	*	I	I	*	I	*	*	I	*	I	I	HESS:VCOM:INLINT
(12)	*	I	I	I	I	I	I	I	I	I	I	I	I	*	I	*	I	*	I	I	*	*	*	*	I	I	*	I	*	*	I	*	I	I	HESS:VCOM:JETOLD
(12)	*	I	I	I	I	I	I	I	I	I	I	I	I	*	I	*	I	*	I	I	*	*	*	*	I	I	*	I	*	*	I	*	I	I	HESS:VCOM:RECJET
(12)	*	I	I	I	I	I	I	I	I	I	I	I	I	*	I	*	I	*	I	I	*	*	*	*	I	I	*	I	*	*	I	*	I	I	HESS:VCOM:JET3
(12)	*	I	I	I	I	I	I	I	I	I	I	I	I	*	I	*	I	*	I	I	*	*	*	*	I	I	*	I	*	*	I	*	I	I	HESS:VCOM:JET3IN
(9)	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	*	I	I	I	*	I	*	*	*	*	I	*	*	I	*	I	I	HESS:AFORM
(15)	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	*	*	*	*	*	*	I	*	*	*	*	I	*	*	*	*	I	*	HESE MATSOL
(15)	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	*	*	*	*	*	*	I	*	*	*	*	I	*	*	*	*	I	*	HESS:MATSOL:COLSOL
(17)	I	I	I	I	I	I	I	I	I	I	I	I	*	I	I	I	*	*	*	*	*	*	I	*	*	*	*	*	*	*	*	*	*	*	HESS:COMFLO
(17)	I	I	I	I	I	I	I	I	I	I	I	I	*	I	I	I	*	*	*	*	*	I	I	*	*	*	*	*	*	*	*	*	*	*	HESS:LOMFLO:PKUTTA
(17)	I	I	I	I	I	I	I	I	I	I	I	I	*	I	I	I	*	*	*	*	*	I	I	*	*	*	*	*	*	*	*	*	*	*	HESS:COMFLO:DLCOMFLO
(17)	I	I	I	I	I	I	I	I	I	I	I	I	*	I	I	I	*	*	*	*	*	I	I	*	*	*	*	*	*	*	*	*	*	*	HESS:BSETUP
(17)	I	I	I	I	I	I	I	I	I	I	I	I	*	I	I	I	*	*	*	*	*	I	I	*	*	*	*	*	*	*	*	*	*	*	HESS:MATSOL
(17)	I	I	I	I	I	I	I	I	I	I	I	I	*	I	I	I	*	*	*	*	*	I	I	*	*	*	*	*	*	*	*	*	*	*	HESS:MATSOL:SOLMOR

TABLE 2.1-2 SUMMARY OF DATA STORAGE FILES

ORIGINAL PAGE IS OF POOR QUALITY

2.2 EXECUTIVE SYSTEM CONTROL CARDS

This routine controls the order in which the routines within VAPE are executed and initializes some parameters for use in the Stockman Program.

E-1 PRIMARY CONTROL CARD (I2, I3, I5, I10, F10.0, I10, F10.2, 5I5, F5.0)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	MTCK	INITMT (I2)	Tape assignment flag = 0 Normal output = 1 Output assignment of scratch files
3	IPROG	INITMT (I3)	Selects stage at which computation begins, default value is 1. Execution begins with: = 1 Geometry module (Stockman) = 2 Potential flow routine (Stockman) = 3 Combination routine (Stockman) = 4 Translator routine (Stockman) = 5 Viscous routine (Stockman) = 6 GEOMOD routine (Stockman) = 7 HESS routine (3-D HESS)
6	IPRG2	INITMT I5	Selects stage at which computation stops default value is 7 Execution stops at: = 1 Geometry routine (Stockman) = 2 Potential flow routine (Stockman) = 3 Combination routine (Stockman) = 4 Translator routine (Stockman) = 5 VISCOUS routine (Stockman) = 6 GEOMOD routine (Stockman) = 7 HESS routine (3D HESS)
11	MXPTS	INITMT I10	Maximum number of points that may be generated by the geometry routine, default value is MXPTS - 180. Large numbers of points* require/excessive computation time, thus this limit can be used to stop execution if it is not desired to use large amounts of computation time.

* Problems where SCIRCL generates 250 points or less have little impact on computer run time. Problems where SCIRCL generates 300 or more points will effect computer run time and should be avoided if possible.

21	TIMX	INITMT F10.0		Maximum amount of computation time that may be used by the potential flow solution routine, default value is TIMX = 200 (seconds). Errors in the geometry input can cause excessive amounts of time to be used in the potential flow solution routine. Program execution is terminated if this limit is exceeded to avoid wasting computation time.
31	IPASS	INITMT I10		If IPASS = 1 & IPRG2 = 1 program execution stops after potential flow solution (Stockman). If IPASS = 1 & IPRG2 =/ 2 or 3 program skips translator, VISCOUS & GEOMOD routines and proceeds directly to 3-D HESS program.
41	XRI2	INITMT		Surface distance increment added to stagnation point or inlet highlite to start boundary layer solution. (Recommend 0.05)
		F10.2		
51	NT(1)	INITMT I5		Number of on-body points for closed end solution.
56	NT(2)	INITMT I5		Number of on-body points for open end solution.
61	NP	INITMT I5		Total number of off-body points
66	NHUBMX	INITMT I5		Number of last points on hub
71	IPLOT	INITMT I5	= 0 = 1	No plots Plots (not checked out)
76	XRPLOT	INITMT F5.0		Last X where data is Plotted (Recommend XRPLOT = XRI)

(1) Note that NT(1), NT(2), NP, and NHUBMX should be input only if IPROG>1. These values are output of SCIRCL.

(2) The parameters from MXPTS through XRPLOT are control values for the nacelle inlet analysis module and are not required if IPROG = 7.

ORIGINAL PAGE IS
OF POOR QUALITY

2.3 STOCKMAN INLET ANALYSIS PROGRAM*

GEOMETRY MODULE

IA-1 TITLE CARD (8A 10)

COLUMN	CODE	ROUTINE FORMAT		EXPLANATION
1	Title	SCIRCL 8A10		Title card If Title (1) = Stop, Control transfers to main routine, input to SCIRCL is complete.

IA-2 CONTROL CARD FOR GEOMETRY MODULE (2A10,4I5)

COLUMN	CODE	ROUTINE FORMAT		EXPLANATION
1	IDENT	SCIRCL A10		Case identifier
11	PROG	SCIRCL A10		Potential flow flag EOD Axisymmetric program Used for identification only.
21	N06	SCIRCL I5		Flag for potential flow solution
			= 0	All solutions
			= 1	Basic geometry data only

* Cards for this module required only if IPROG = 1 on card E-1.

IA-3 GEOMETRY DISTRIBUTION CONTROL CARD (8F10.2)

COLUMN	CODE	ROUTINE FORMAT		EXPLANATION
1	ANBDYS	SCIRCL F10.2		Number of input bodies
			= 1	Shroud (cowl) only
			= 2	Hub and shroud
			= 3	Hub, flow splitter plates and shroud
11	DELS	SCIRCL F10.2		Spacing between points in region of interest, DELS affects total number of points, solution accuracy, and computer run time.
21	DELSMX	SCIRCL F10.2		Maximum spacing used far from region of interest. DELSMX must be less than inlet duct flow width
31	XRI	SCIRCL F10.2		Axial location of point of interest. Point at which surface distance equals zero. Spacing between points is kept at approximately DELS up to XRI, then spacing increases to DELSMX far from region of interest. XRI should be located in constant area section downstream of the assumed fan face of the inlet.
41	ANNSD	SCIRCL F10.2		Number of noise suppression devices or NSD splitter (can be zero)

ORIGINAL PAGE IS
OF POOR QUALITY

IA-4 CONTROL CARD FOR RAKES (20I5)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	NRAKES	SCIRCL I5	Number of axial locations at which data across the passage is desired. At least one is required @ XRI. $1 \leq$ NRAKES ≤ 25

IA-5 RAKE DEFINITION CARD (I10, 3F10.5)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	NY	SCIRCL I10	Number of points in rake at XRAK. Total number of points for all rakes limited at 200, NY $\leq$ 200, ΔY = (YHI-YLO)/NY
11	XRAK	SCIRCL F10.5	Axial location of rake $XRAK_{i+1} \geq XRAK_i$
21	YLO/	SCIRCL F10.5	Y value of first point on the rake (must be an off body point)
31	YHI	SCIRCL F10.5	Y value of last point on the rake (must be an off body point)

Note: One rake definition card for each rake: thus NRAKES number of cards input here

IA-6 BODY CONTROL CARD (8F10.0) ONE CARD FOR EACH BODY

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	TYPBDY	SCIRCL F10.0	Body identification flag See table below
11	ANSEG	SCIRCL F10.0	Number of segments for the particular body, see TYPBDY. If TYPBDY = 0, it is the Y centerline used for mirroring.

TABLE I
Use of Parameter TYPBDY

Value of ANBDYS	VALUE of TPYBDY 0	1	2	3
1			shroud	
2	centerline	hub	shroud	
3	centerline	hub	*flow splitter	shroud

Analytical Functions

The inlet surfaces can be described by combining parts of six available analytical functions, as shown in Figure 2-1. The coefficients for each analytical function used are determined by the program from the coordinate points input. The number of coordinate sets needed varies with each analytical function as listed in Table II, and shown in Figure 2-1.

IA-7 SURFACE CURVE IDENTIFICATION CARD a1 (10X, 7F10.2)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
11	ENREED	SCIRCL F10.2	code indicating type of curve to be fitted through the given points, it is also the exponent for a superellipse when the exponent is to be specified. (See Table II Below) ENREED = 0.0, SCIRCL program will calculate an exponent. Read in 5 coordinates (XIN and YIN). (fig. 2-1(a)) 1.0 < ENREED < 10.0, superellipse with exponent equal to ENREED. Input coordinates 1,2,4,5. Read in 0.0 for point no. 3. (Point no. 3 is not used, but points 4 and 5 must be in the proper columns.) (fig. 2-1(b))

			1001. < ENREED < 1010. The flag 1000. added to the code of desired superellipse is used on the shroud to give finer spacing at the highlight. The superellipse going into the highlight and the one of the topside of the highlight should have this flag. ENREED = 1.0, is a straight line, input 2 coordinates (XIN (1), YIN(1), XIN(2), YIN(2)). (fig. 2-1(c)). ENREED = 10.0, special straight line used for closed bodies (example - airfoils). This straight line starts with large spacing (DELSMX) and ends with the small spacing (DELS). Input 2 coordinates. (fig. 2-1(d)). ENREED = -1.0, fits a lemniscate between a straight line and a point. Input is 3 coordinates. (fig. 2-1(e)) ENREED = -2.0, fits an ellipse between two straight lines. Input 4 coordinates. Restriction, the two straight lines should be at a right angle, therefore superellipse routine can be used. (fig. 2-1(f)) ENREED = -3.0, fits a cubic between 2 straight lines, input 4 coordinates. (fig. 2-1(g))
21	XIN(1)	SCIRCL F10.2	X value of first input point
31	YIN(1)	SCIRCL F10.2	Y value of first input point
41	XIN(2)	SCIRCL F10.2	X value of 2nd input point
51	YIN(2)	SCIRCL F10.2	Y value of 2nd input point
61	XIN(3)	SCIRCL F10.2	X value of 3rd input point
71	YIN(3)	SCIRCL F10.2	Y value of 3rd input point

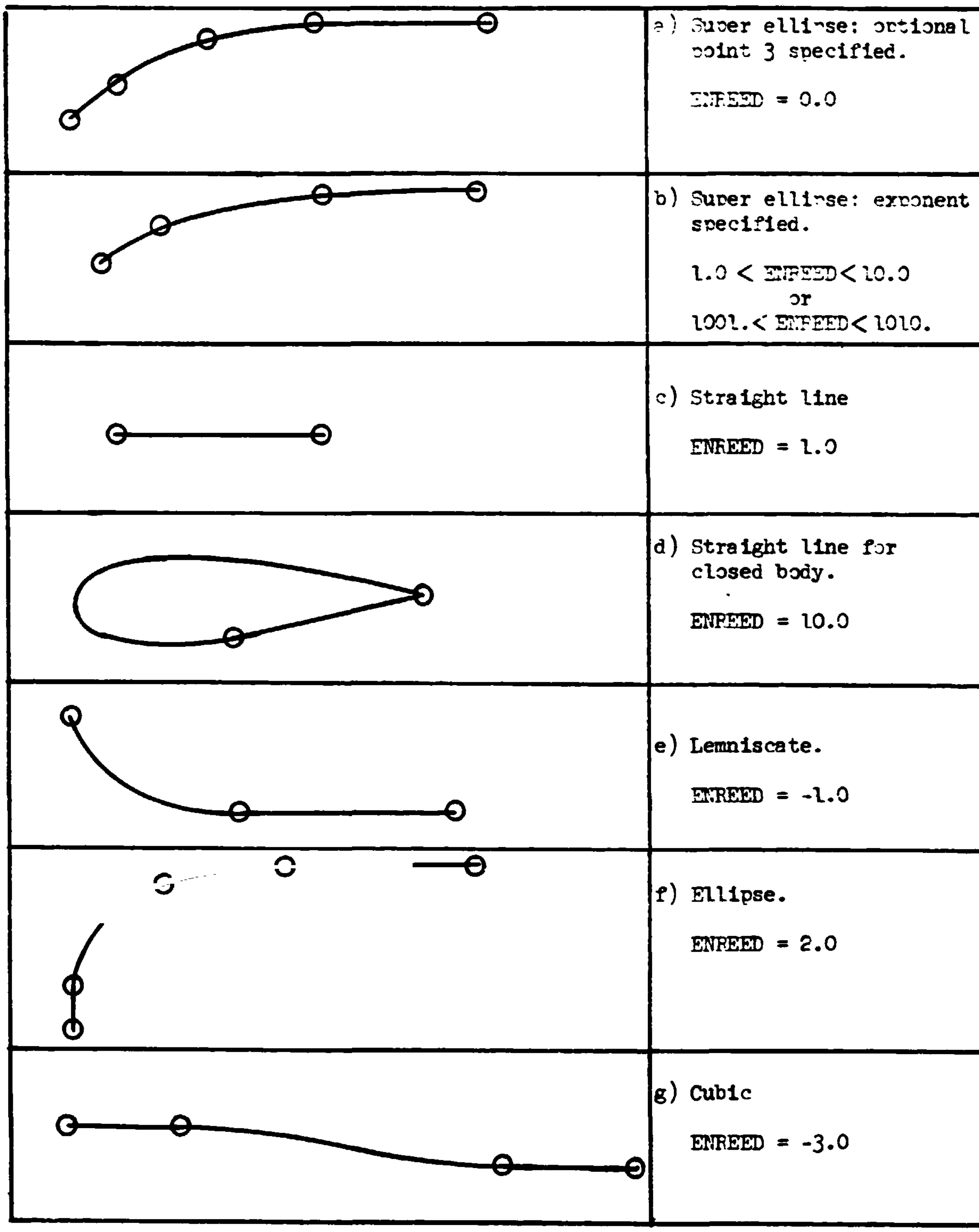


Figure 2-1. Analytical functions available for describing inlet surfaces

IA-8 SURFACE CURVE IDENTIFICATION CARD #2 (8F10.2)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	XIN(4)	SCIRCL F10.2	X value of 4th input point
11	YIN(4)	SCIRCL F10.2	Y value of 4th input point
21	XIN(5)	SCIRCL F10.2	X value of 5th input point
31	YIN(5)	SCIRCL F10.2	Y value of 5th input point

TABLE II
Analytical Functions Available

Curve	Code ENREED	Number of Points Needed	Portion Used (Figure 2-1)
Cubic	3.0	4	2 to 3
Ellipse	2.0	5	2 to 4, point 3 is a dummy pt
Lemniscate	1.0	3	2 to 3
Super Ellipse	0.0	5	2 to 4
Straight Line	1.0	2	1 to 2
Super Ellipse	1.0 to 10.0 1001. to 1010.	4 4	2 to 4, pt. 3 optional 2 to 4, extra fine grid
Straight Line	10.0	2	straight line for closed body

There should be ANSEG number of the above two cards input at this point. Additionally, there should be the last three cards repeated for each body (ANBDYS) at this point.

IA-9 SPLITTER BODY DEFINITION CARD #1 (8F10.2) (input only if ANNSD >0)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	DELS	SUPRD F10.2	Spacing between points on the NSD splitter, can be different than DELS on the body

IA-10 SPLITTER BODY DEFINITION CARD #2 (16I5) (input only if ANNSD >0)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	NSEG	SUPRD I5	Number of segments on the NSD splitter. For a thin NSD splitter, segments on the topside should begin and end at the same X values as corresponding segments on the underside.
6	NSHIGH	SUPRD I5	Number of the segment on the underside of the NSD going into the highlight, equal to 1/2 of NSEG for thin splitter. Set NSHIGH = NSEG for all other splitters.

ORIGINAL PAGE IS OF POOR QUALITY

IA-11 SPLITTER SURFACE CURVE IDENTIFICATION CARDS (10X, 7F10.2) (Input only if ANNSD >0)

The information on the geometry identification card and the surface curve identification card must be input for the splitter using same definitions and card form as given above for these two cards so input ENREED, XIN(1), YIN(1) through XIN(5), YIN(5) at this point for splitter

REMARKS, Total number of points for all the bodies should not exceed 400.

The first straight line on the shroud must be equal in axial length to the last straight segment on the hub. If the first straight line on the shroud is longer, use two segments.

Total number of off-body points must not exceed 200. If there are acoustic splitters in the area of a rake, specify ANNSD + 1 rakes for axial location of rake.

AXISYMMETRIC POTENTIAL FLOW PROGRAM

The Axisymmetric Potential Flow Program is the second part of the Stockman inlet analysis procedure. The output from SCIRCL (The Geometry Module) is used in this sub-program. The results of this sub-program are used by the combination routine to determine the flow field.

If data is being transfered from SCIRCL and NIN ≠ 0 or NIN ≠ 5 then only the following card is input for the potential flow program.
Input data only if IPROG = 2 on card E-1.

AP-1 <u>POTENTIAL FLOW CONTROL CARD (2I5)</u>

COLUMN	CODE	ROUTINE FORMAT		EXPLANATION
1	NIN	EOD I5		input tape for EOD, normally generated by SCIRCL
			= 5	data input on cards (card must follow)
			= 20	data being transfered from SCIRCL
6	IEODW	EOD I5	≠ 0	extra printout for debugging of program (normally set 20)

If NIN = 5, then the following cards must be input. If NIN = 20, then skip to combination program card description.

AP-2 <u>TITLE CARD (5A10, A7, 5X, I10)</u>

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	HEDR	PART1 5A10	title of case.
51	CASE	PART 1 A7	case identi [illegible]
63	SEQ1	PART 1 I10	sequence number of this card in the input scheme

AP-3 <u>FLAG CARD (28I1, I2, 32X, I10)</u>

Card columns 1-30 when punched with any non-zero integer, activate flags that indicate the following:

COLUMN	CODE	ROUTINE FORMAT		EXPLANATION
1	NB	PART1 I1		The number of bodies input. Normally set equal to 1. $1 \leq NB \leq 5$
2	NNU	PART1 I1		The number of non-uniform onset flows. Normally set equal to 0.
3	FLG03	PART1 I1		Axisymmetric flow flag.
			-0	No axisymmetric stream-flow solution calculated.
			-1	Axisymmetric streamflow solution is calculated
				Normally set equal to 1
4	FLG04	PART1 I1		Cross flow flag.
			=0	No cross flow solution is calculated
			=1	Cross flow solution is calculated
				Normally set equal to 0
5	FLG05	PART1 I1		Off-body point flag
			=0	No off body points input
			=1	Off body points are input
				This flag allows the velocity at points off the body surface to be determined.
6	FLG06	PART1 I1		Basic data formation flag
			=0	A full case will be done
			=1	The basic data, i.e., midpoints, normals, etc. will be formed and printed. No velocities will be calculated.
7	FLG07	PART1 I1		Ellipse generator option
			=0	Body coordinates will be input
			=1	An ellipse is generated using data input later. No body coordinates are input
8	FLG08	PART1 I1		Matrix print flag
			=0	Coefficient matrices are not printed.
			=1	Coefficient matrices will be printed.
				Normally set equal to 0

9	FLG09	PART1 I1		Matrix solution flag #1
			=0	Matrix solution set later
			=1	Old SIEDEL method used
10	FLG10	PART1 I1		Matrix solution flag #2
			=0	Matrix solution set elsewhere
			=1	Modified SIEDEL method used
11	FLG11	PART1 I1		Perturbation velocity flag
			=0	Normal case
			=1	No onset flow used. Only perturbation velocities are calculated.
12	FLG12	PART1 I1		Potential matrix solution
			=0	Normal case
			=1	A potential matrix is solved
13	FLG13	PART1 I1		Matrix solution flag #3
			=0	Matrix solution set elsewhere
			=1	Matrix solution by triangularization
				Normally set equal to 1.
14	FLG14	PART1 I1		Prescribed tangential velocity flag
			=0	Normal case
			=1	Tangential velocities are specified
15	FLG15	PART1 I1		Strip ring vorticity flag
			=0	Normal case
			=1	A vorticity distribution is formulated.
16	FLG16	PART1 I1		Axisymmetric uniform flow flag
			=0	Normal case
			=1	Axisymmetric uniform flow solution is omitted
				Normally set equal to 0.

17	FLG17	PART1 I1		Crossflow uniform flow flag
			=0	Normal case
			=1	Crossflow uniform flow solution is omitted.
				Since FLG04 is normally = 0 then so is FLG17 normally set equal to 0.
18	FLG18	PART1 I1		Surface vorticity flag
			=0	Normal case
			=1	Surface vorticity is generated.
19	FLG19	PART1 I1		Prescribed vorticity Flag
			=0	Normal case
			=1	A prescribed vorticity is input
20	FLG20	PART1 I1		Total vorticity flag
			=0	Normal case
			=1	Total vorticity calculated
21	FLG21	PART1 I1		Extra crossflow flag
			=0	Normal case
			=1	Extra crossflow option used
22	FLG22	PART1 I1		Generated boundary condition flag
			=0	Normal case
			=1	Boundary conditions generated
23	FLG23	PART1 I1		Ring wing option flag
			=0	Normal case
			=1	Ring wing option used
24	FLG24	PART1 I1		Not used by this program
25	FLG25	PART1 I1		Not used by this program
26	FLG26	PART1 I1		Not used by this program

27	FLG27	PART1 I1		Not used by this program
28	IPUVEL	PART1 I1		Punch flag
			0=	No data punched
			=1	Punched output generated
29	NDUM	PART1 I1		Not used by this program
63	SEQ2	PART1 I1		Sequence number of this case in the input stream

AP-4 CHORD CARD (3F10.0, 32X, I10)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	CHORD	PART1 F10.0	Reference chord length used to non-dimensionalize x and y coordinates
11	MN	PART1 F10.0	Mach number (MN < 1.0) use to approximate effect of compressibility (Gothert' rule)
21	TCNST	PART1 F10.0	This is a constant which is used for the value of the tangential velocity if this option is desired.
62	SEQ2	PART1 F10.0	Sequence number of card in input stream

AP-5 BODY TRANSFORMATION CARD (5X, I5, 5F10.0, 16X, I4)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
5	NN	BASIC1 I5	The number of input points on this body. NN ≤ 500
11	MX	BASIC1 F10.0	A factor used to multiply all x-coordinates. MX is assumed equal to 1 if no valve is input.
21	MY	BASIC1 F10.0	A factor used to multiply all y-coordinates. MY is assumed equal to 1 if no value is input.
31	THETA	BASIC1 F10.0	An angle (in degrees) through which all points of a body are to be rotated about the origin in the clockwise direction.

41	ADDX	BASIC1 F10.0		A constant to be added to all x-coordinates
51	ADDY	BASIC1 F10.0		A constant to be added to all y-coordinates
76	SEQ2	BASIC1 I4		Sequence number of this card in input stream

AP-6 BODY CONTROL CARD (3(5X, I5), 2F10.0, 26X, I4)

COLUMN	CODE	ROUTINE FORMAT		EXPLANATION
6	BDN	BASIC1 I5		Body sequence number. This program will handle up to 5 bodies.
16	SUBKS	BASIC1 I5		Subcase Flag.
			=0	Normal case
			=1	Use unmodified coordinates of the previous case.
26	NLF	BASIC1 I5		Non-lifting flag
			=0	Body is lifting (this is used in special option)
			=1	Body is non-lifting (normal case)
31	XE	BASIC1 F10.0		Value of major semi-axis for use by ellipse generation option.
41	YE	BASIC1 F10.0		Value of minor semi-axis for use by ellipse generation option
				Note: if XE = YE a sphere will be formed.
76	SEQ2	BASIC1 F10.0		Sequence number of this card in the input stream

GEOMETRY DATA CARDS (6F10.0, 16X, I4)

The body geometry data cards are included only if the input parameters NIN = 0 or 5 and SUBKS = 0 on the body control card. If NIN = 20 then the data is read from unit 20. If NIN = 5 and BDN = 0 then the following cards contain the x-y coordinates of off-body points instead of x-y geometry data. The number of either geometry data point or off-body points must be equal to NN.

AP-7 X-COORDINATE CARDS (six values per card)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	TX1(1)	BASIC1 6F10.0	x-coordinates of body input from leading to trailing edge
11	TX1(2)	BASIC1 6F10.0	
21	TX1(3)	BASIC1 6F10.0	
etc.			
76	SEQ2	BASIC1 I4	Sequence number of this card in the input stream

AP-8 Y-COORDINATE CARDS (six values per card) (6F10.0, 16X, I4)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	TY1(1)	BASIC1 6F10.0	y-Coordinates of body which correspond to the x-values above. y values must be positive.
11	TY1(2)		
21	TY1(3)		
etc.			
76	SEQ2	BASIC1 I4	Sequence number of these cards in input stream

NOTE: Each body input, including the off body points, requires the body transformation card, the body control card, and may also require the geometry data cards depending on the input flags. This is the stopping place for a normal axisymmetric case. The following cards are input only if one of the special options is required.

AP-9 TANGENTIAL VELOCITY DATA CARDS (six values per card) (6F10.0, 16X, I4)

These cards are input only if FLG14 $\neq$ 0 and TCNST = 0.0

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	TG(1)	BASIC1 6F10.0	Specified tangential velocities at element midpoints.
11	TG(2)		

21	TG(3)		

etc.

76	SEQ2	BASIC1 I4	Sequence number of these cards in input stream

AP-10 NON-UNIFORM FLOW CARDS

This card is input only of NNU ≠ 0.

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
6	NUM	BASIC2 I5	Non-uniform flow identification number.
16	MSF	BASIC2 I5	If MSF = 1 the flow velocities N_0, T_0 will be be used for the axisymmetric case only. If MSF = 1 the flow velocities N_0, T_0 will be used for the cross flow case only. If MSF > 1 the flow velocities will be used for both axisymmetric and cross flow cases.
21	TYPE	BASIC2 F10.0	Flag which specifies the type of input flow velocities at each mid-point. If TYPE > 0.0, the velocities are input as x & y components. If TYPE = 0.0 the velocities are input as normal & tangential components. If TYPE < 0.0 the automatic generation of the flow due to a rotating body is used.
31	FG	BASIC2 F10.0	Constant used by the flow generator. Type must be less than 0.0.
76	SEQ2	BASIC2 I4	Sequence number of this card in the input stream

The following cards are input only if NNU ≠ 0 and TYPE ≠ -1.0.

AP-11 NORMAL VELOCITY CARDS (six values per card)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	NG(1)	BASIC2 F10.6	This is either the x or normal velocity component depending on the value of type above. These values must be in sequence with the coordinate data. If the x component is

			input it is defined as positive to the right. If the normal velocity is input it is positive if it is to the interior of the body. NN-1 values are input.
76	SEQ2	BASIC1 I4	Sequence number of this card cards in input stream

AP-12 TANGENTIAL VELOCITY CARDS (six values per card)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	TG(1)	BASIC2 6F10.0	This is either the y or tangential velocity component depending on the value of type above. These values must correspond to the NG values above. If the y component is input it is defined as positive if it is orientated upwards. If the tangential velocity is input it is positive if the flow field is to the left of the vector representing the tangential velocity.
76	SEQ2	BASIC2 I4	Sequence number of this card in the input stream

INPUT FOR COMBINATION PROGRAM

C-1 TITLE CARD (8A10)

COLUMN	CODE	ROUTINE FORMAT		EXPLANATION
1	TITLE	READS 8A10		Title of this case If title(1) input as end control returns to main program - input for combination program complete

C-2 COMBINATION ROUTINE CONTROL CARD (20I5)

COLUMN	CODE	ROUTINE FORMAT		EXPLANATION
1	NID	READS I5		Number of ID cards from EOD output. NID = 1 except when closed end and open end cases run separately. Then NID = 2.
6	KSKIP	READS I5	= 0 = 1	For 1 case of COMPYN For successive cases using the same EOD output.
11	N4SOL	READS I5		N4SOL = 0 when there are three solutions from EOD (one axisymmetric solution for each closed and open end cases and one crossflow solution for closed end). N4SOL = 1 when there are four solutions from EOD (solution for crossflow with open end is added).
16	NSPLT	READS I5		Number of noise suppression devices (splitters): can equal zero.
21	KEYCOM	READS I5	 = 1 = 2 = 3	Onbody data punch FLAG for data transfer Shroud Data Hub Data Shroud & Hub Data
26	KEYRK	READS I5		The number of X's at which Vx, Vy, Vz is to be obtained.

C-3 ONBODY INPUT CARD (4F10.5)

COLUMN	CODE	ROUTINE FORMAT		EXPLANATION
1	XRAG1	READS F10.5		See Tape C-1.
11	XRAG2	READS F10.5		See Tape C-1.

TABLE C-1

Use of Parameter XRAG

KEYCOM	XRAG PARAMETERS	NOTES
1	XRAG1 = Start value for shroud data (inside) XRAG2 = End value for shroud data (outside) XRAG3 and XRAG4 not used	(A) If XRAG1 > 0 and and XRAG2 > 0 — Normal mode and checks for X valves on the shroud from inside to outside (B) XRAG1 < 0 ABS (XRAG1) > XRAG2 — Mode by which only X values on inside surface of the shroud are obtained (C) XRAG1 < 1 ABS (XRAG1) < XRAG2 — Mode by which only X values on external surface of the shroud are obtained

C-4 OFFBODY INPUT CARD (8F 10.5) (input only if KEYRK >0)

1	XOFFM(1)	READS F10.5	Offbody X at which Vx, Vy, Vz to be obtained.
11	XOFFM(2)	READS F10.5	Input KEYRK values 8 values per card.
21			
71			

C-5 NOISE SUPPRESSION SPLITTER INPUT (2015) (input only if NSPLT >0)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	NSPB(1)	READS I5	Number of right most point on Splitter.
6	NSPE(1)	READS I5	Number of left most point on Splitter.

11	NSPB(2)	READS I5
16	NSPE(2)	READS I5

Input NSPLT values of NSPB and NSPE >8 values to a card.

NOTE: The first Splitter is the one closest to the hub and the last Splitter is the one closest to the shroud.

C-6 FLOW CONTROL CARD #1 (8F10.2)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	VC	READS F10.2	Average axial velocity at the control station. Based on live flow area, i.e., the flow area minus the area associated with the boundary layer displacement thickness. If VC = 0.0 the program will interpret this as a code and will calculate VC from WDOT. (To run a case with VC actually equal to zero set WDOT = 0.0) (FT/SEC)
11	VINF	READS F10.2	Free Stream Velocity (FT/SEC)
21	ALFAF	READS F10.2	Angle of attack, 0.0 for free stream perpendicular to inlet axis (α_F = X-90°) degrees
31	TTOTAL	READS F10.2	Total temperature, if PSTAT and TSTAT are read in (to be explained later), the program will calculate TTOTAL. If TTOTAL = 0 and PSTAT and TSTAT = 0, then TTOTAL = 518.67 degrees R.
41	ELND	READS F10.2	Arbitary length used for normalizing (see KND card C-8 for further description) FT.
51	YWING	READS F10.2	Not used in this program version YWING is the upper limit integration for surface forces.
61	UTIP	READS F10.2	Rotor tip speed (not required unless relative rotor inlet quantities are desired).

ORIGINAL PAGE IS
OF POOR QUALITY

71	VA	READS F10.2	Bulk velocity at control station, i.e., average inlet axial velocity based on geometric area. If VA = 0.0, the program will interpret this as a code and set VA = VC.

C-7 FLOW CONTROL CARD # 2 (8F10.2)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	PT	READS F10.2	Total pressure, if PT = 0 program sets PT = 2116 lbs/ft^2 (lbs/FT^2)
11	PSTAT	READS F10.2	Static pressure, if input as zero, program will calculate (lbs/FT^2).
21	TSTAT	READS F10.2	Static temperature, if input as zero, program will calculate (lbs/FT^2).
31	WDOT	READS F10.2	Weight flow (input only if VC is input = 0.0).
41	DELQ	READS F10.2	Increment for value of stream function.

C-8 GEOMETRY CONTROL CARD (20I5)

COLUMN	CODE	ROUTINE FORMAT		EXPLANATION
1	NTHETA	READS I5		Number of THETAS, where THETA is the circumferential coordinate.
6	NCLO	READS I5		One rake must be chosen as the control station. NCLO is the number of the first point on the rake.
11	NCHI	READS I5		The number of the last point on the control station rake.
16	NX	READS	= 0	No XTEST values read.
		I5	≠ 0	XTEST values must be input.
21	KND	READS		Flag used for non-dimensionalizing,
		I5	KND = -1,	ELND = YRISHR
			KND = 0,	ELND = 1.0 (no nondimensionalizing)
			KND = 1,	ELND = YRISHR - YRIHUB
			KND = 2,	ELND is the read in value For the above the velocities are normalized by VC.
			KND = 4,	same as KND = -1 but VA is used for normalizing velocities.

KND = 5	same as KND = 0, velocities normalized by VA.
KND = 6	same as KND = 1, velocities normalized by VA.

C-9 THETA INPUT CARDS (8F10.2)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	THETA(1)	READS F10.2	Circumferential coordinate in degrees. Note that the last theta read will be the data set used to calculate the boundary layer solution in VISCUS.
11	THETA(2)		

Input NTHETA values 8 values per card

C-10 X TEST CARDS (8F10.2) (NX 70)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	XTEST(1)	READS F10.2	Axial location of control surface, usually set equal to XRI
11	XTEST(2)		

Input NX values 8 values per card

C-11 GEOMETRY DEFINITION CARD (8F10.2)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	XRI	READS F10.2	Value of X (axial coordinate) where surface distance is zero, usually equal to X at the control station.
11	YRIHUB	READS F10.2	Y value on HUB at X = XRI
21	YRISHR	READS F10.2	Y value on SHROUD at X = XRI

C-12 DATE CARD NO. 1 (4X, 3I2, I5) (Read only if KSKIP = 0)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
5	MO	READS I2	Month of EOD run which produced potential flow solution.

7	JA	READS I2	Day of EOD run which produced potential flow solution.
9	IR	READS I2	Year of EOD run which produced potential flow solution.
11	NRUNNO	READS I5	Run number corresponding to date of computer program run date given above.

C-13 DATE CARD NO. 2 (4X, 3I2, I5) (Read only if KSKIP = 0 AND NID > 1)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
5	MO2	READS I2	See MO above
7	JA2	READS I2	See JA above
9	IR2	READS I2	See IR above
11	NRUNNO2	READS I2	See NRUNNO above

* This card is input only if the open and closed potential flow solutions were run separately.

The following cards are input for force and moment option.

C-14 INLET GEOMETRY CARD NO. 1 (8A10)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	TITLE	READS (8A10)	Problem identification card

C-15 INLET GEOMETRY CARD NO. 2 (I2, 8X, I2)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	NINT	READS I2	Total number of internal surface geometry points input
11	NOUT	READS I2	Total number of external surface geometry points input

C-16 INLET GEOMETRY CARD NO ` (3F10.0)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	XI(I)	READS F10.0	Internal surface geometry from SCIRCL output (in combined routine)
11	YI(I)	READS F10.0	Data proceeds from XRAG1 to hilite location
21	OYDXI(I)	READS F10.0	

There will be NINT cards input (I = 1, NINT)

C-17 INLET GEOMETRY CARD NO. 4 (3F100)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	XO(I)	READS F10.0	External surface geometry from SCIRCL output (in combined routine)
11	YO(I)	READS F10.0	Data proceeds from hilite location to XRAG2
31	DYDXO(I)	READS F10.0	

There will be NOUT cards input (I = 1, NOUT)

NOTE: X = Axial Coordinate
Y = Radial Coordinate
OYDX = Surface Slope

C-18 FLOW FIELD DATA CARD NO. 1 (8A10)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	TITLE	READS 8A10	Problem Identification

C-19, 20 FLOW FIEL DATA CARD NO. 2 AND NO. 3 (NAMELIST)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
2-72	$IN	READS (NAMELIST)	NAMELIST identified
	PAMB		Ambient Pressure, lbs/in^2
	TAMB		Ambient Temperature, ^oR

	VFLIGHT		Free Stream Velocity, FT/SEC
	NACANS		Nacelle Tilt Angle, degrees
5-72	ACALPHA	READS (NAMELIST)	Aircraft Angle of Attack, degrees
	SIDSLIP		Sideslip Angle, degrees
	S*		Distance outboard to moment reference point, inches
	L*		Distance from high lite along inlet centerline to moment reference point, inches
	$		Terminator

*EXAMPLE: Reference point defined at the inlet high lite is S = 0.0, L = 0.0

NOTE: $IN must start in column 2. Flow conditions variables follow with a comma separating one from another. If the data list is too large for one card, a second card can be used provided the data is listed after column 2. Do not end a card with a comma. The namelist is ended with a $.

C-21 FLOW CONDITION DATA CARD NO. 4

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	INANG	READS F10.0	Angle between relative wind and inlet centerline
21	NPSIN	READS I2	Number of circumferential positions (on body)

C-22 FLOW CONDITION DATA CARD NO. 5

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	NRAD	READS I2	Number of circumferential positions (off-body)
11	NCIRC	READS I2	Number of data cards. This will equal the number of points per rake defined in SCIRCL
21	XFLOW	READS F10.0	Off-body axial station (face station)

C-23 FLOW CONDITION DATA CARD NO. 6

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	RADIUS(I)	READS (8F10.0)	Off body radial position. These will be defined in the COMBYN output from the combined routine. There will be NCIRC number of RADIUS(I) data.

SPECIAL INSTRUCTIONS

The geometry data must cover the inlet boundaries defined in the combined input. These boundaries must be broad enough to include the predicted stagnation point at each circumferential angle. If the boundaries are not broad enough, an error message will be printed.

When defining the induced angle to calculate the forces and moments, the aircraft centerline and the Nacelle centerline must be parallel. Therefore, in general, NACANG should equal 0.0 and ACALPHA should equal the incidence angle. Then INANG = ACALPAA.

INPUT FOR TRANSG PROGRAM

This program takes data from the COMBYN program and translates, scales, and sets up the data for input to sub-program viscus.

T-1 TRANSG CONTROL CARD (F10.0)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	XBLTZ	TRANSG F10.0	X station in the inlet where the boundary layer solution ends. Usually it is equal to XRI.

INPUT FOR VISCOUS ROUTINE

Since the program does not use any constants which depend on the system of units (except the Free-stream total temperature), any consistent set of units may be used.

V-1 SWITCH ARRAY CONTROL CARD (15I5)

COLUMN	CODE	ROUTINE FORMAT		EXPLANATION
1	ISTO(1)	COTR I5	< 0	Data input on unit 31
			≤ 0	Data input on unit 5
			≠ 0	Input data listed
			= 999	Program returns at this point
6	ISTO(2)	COTR I5	= -1	Do not list profiles except at the X-location denoted by ISTO(7) or at the last X-location calculated if separation occurs.
			= 0	Profiles are listed at each point to the profile end if U/V ≤ 1.: if U/V > 1 at end and WSTO(1) ≤ 1 each succeeding point is listed unless ISTO(4) ≠ 0 then overshoot portion is suppressed entirely.
			= 1	File lists only the profile end values at the wall and boundary layer edge.
			= 2	Profiles are listed on each point to the first point greater than WSTO(1).
			= 3	Profiles are listed on each point at the JDIV interval to the profile end.
			≥ 3	or LT < -1 only the value of the profile at the wall is listed.
11	ISTO(3)	COTR I5		Used to compute the profile point list interval. List interval = ISTO(3) *JDIV
16	ISTO(4)	COTR I5	≠ 0	List for overshoot portion of profile (U/V) > 1 is suppressed.
21	ISTO(5)	COTR I5	= 1	POP = 0 Lists momentum & energy equation boundary values for each iteration.
			= 0	Do not list transition statistics or viscosity functions at the wall.
26	ISTO(6)	COTR I5	= 1	Energy and momentum balances COF1 , COF2 etc. together with their ratio are listed for all computed X-stations.

31	ISTO(7)	COTR I5	≥	X-location number that a profile list is required.
36	ISTO(8)	COTR I5	≥ 1	Used to include a linear section of X-station data from X = 0 to some X-location specified by slope test. The end point of the linear section after the interpolation or new X points equals ISTO(8) + X-station number of the last station input before the interpolation. The total number of X-station points will be increased by ISTO(8) +1. This option should be used only when the slope or the input data increases somewhere between X = 0 and the first maximum.
41	ISTO(9)	COTR I5		Determines the end-point of the linear section. If the X-station data input > than ISTO(9) +2 begin the slope test.
46	ISTO(10)	COTR I5		Not used by program
51	ISTO(11)	COTR I5	= 1 = 2	One set of station data read in on tape. More than one set of station data read in on tape
56	ISTO(12)	COTR I5		Non-dimensionalizes X-station data after computations if ISTO(12) = 0 and WSTO(10) = 0 X-station data are non-dimentionalized by the last X-value.
61	ISTO(13)	COTR I5	= 1	List full profile near zero shear
65	ISTO(14)	COTR I5	= 1	Turbulent restart occurs at point of laminar separation.
71	ISTO(15)	COTR I5	= 0	Station data input on tape
			≠ 0	Station data input on cards.

V-2 CONTROL CARD WSTO(NO. 1) (5E15.8)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	WSTO(1)	COTR E15.8	Limit for U/V usually = .9999
16	WSTO(2)	COTR E15.8	Used to limit amplitude of profiles U/V for calculation.

ORIGINAL PAGE IS
OF POOR QUALITY

31	WSTO(3)	COTR E15.8	Used to recalculate RDT(I) if IOP = 4 WSTO(3) = 1/ (I)
46	WSTO(4)	COTR E15.8	Used only if [RX * RW(I)]^2 ≥ 1
61	WSTO(5)	COTR E15.8	Used as scale factor for X(I) before computations.

V-3 CONTROL CARD WSTO(NO. 2) (5E15.8)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	WSTO(6)	COTR E15.8	See WSTO(4)
16	WSTO(7)	COTR E15.8	See WSTO(4)
31	WSTO(8)	COTR E15.8	Scale factor for U(I)
46	WSTO(9)	COTR E15.8	Scale factor for GP(I)
61	WSTO(10)	COTR E15.8	If WSTO(10) = 0 and ISTO(12) = 0 set WSTO(10) = X(IX) (IX refers to last computed x station. If WSTO(10) ≠ 0 X is non-dimensioned after computation and X(I) is scaled X(I) = X(I)/WSTO(10).

V-4 CONTROL CARD WSTO(NO. 3)(5E15.8)

COLUMN	CODE	ROUTINE FORMAT		EXPLANATION
1	WSTO(11)	COTR E15.8		Used to compute RDT(I) if IOP = 7 & DUP > 0 RDT(I) = $\frac{U(I)DT(I)}{WSTO(11)}$ where WSTO(11) = ν {if WSTO(11) = 0 program sets WSTO(11) = .1564 x 10^{-3}}
16	WSTO(12)	COTR E15.8		Not used
31	WSTO(13)	COTR E15.8		Value of TURB(I) in the transition region for which turbulent restart will be allowed.
46	WSTO(14)	COTR E15.8	= 0 ≠ 0	Set PRT(turbulent prandil no) = 1.0 PRT = WSTO(14)

61	WSTO(15)	COTR E15.8	= 0 ≠ 0	Molecular pranatl no. = .78 PR = WSTO(15)

V-5 CONTROL CARD WSTO(NO. 4) (5E15.8)

COLUMN	CODE	ROUTINE FORMAT		EXPLANATION
1	WSTO(16)	COTR E15.8		Conversion factor for U(I) ≠ 0. Then U(I) = WSTO(16) * U(I)
16	WSTO(17)	COTR E15.8	≠ 0	Than GBC scaled by WSTO(17)
31	WSTO(18)	COTR E15.8		Sonic velocity corresponding to static temperature at start of boundary layer calculation.
46	WSTO(19)	COTR E15.8		Static temperature at start of boundary layer calculation.
61	WSTO(20)			Not used by this program.

V-6 TITLE CARD (18A4)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	LABEL	COTR 18A4	Title for this case

V-7 CONTROL CARD NO. 1 FOR INPUT PROFILES (15I5)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	JDIV	COTR I5	Number of subintervals of f'(n) and g'(n) input profiles, JDIV ≤ 300

V-8 CONTROL CARD NO. 2 FOR INPUT PROFILES (15I5)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	JY	COTR I5	Total number of n values of f'(n) and g'(n) input profiles, JY ≤ 300

V-9 PROFILE INPUT CARDS (6F10.5)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	YY(1)	COTR F10.5	First profile value.

ORIGINAL PAGE IS
OF POOR QUALITY

11	YY(1+JDIV)	COTR F10.5	Second profile value.
21	YY(1+2JDIV)	COTR F10.5	Third profile value

etc. input until YY(JY) is reached. Input 6 values per card.

V-10 CONTROL CARD FOR F'(η) INPUT (15I5)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	JEF	COTR I5	Total number of f'(η) values on the input profile.

V-11 f'(η) INPUT CARDS (6F10.5)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	FP(1)	COTR F10.5	1st f'(η) profile value
11	FP(1+JDIV)	COTR F10.5	2nd f'(η) profile value
21	FP(1+2JDIV)	COTR F10.5	3rd f'(η) profile value

etc. input until FP(JEF) is reached. Input 6 values per card.

V-12 CONTROL CARD FOR g' (η) INPUT (15I5)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	JEG	COTR F10.5	Total number of g'(η) values on input profile.

V-13 g'(η) INPUT CARDS (6F10.5)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	GP(1)	COTR F10.5	1st value of g'(η) profile value
11	GP(1+JDIV)	COTR F10.5	2nd value of g'(η) profile value

21	GP(1+2JDIV)	COTR F10.5	3rd value of g'( ) profile value

etc. input until GP(JEG) is reached. Input 6 values per card.

V-14 PROGRAM OPTION CARD (15I5)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	IOP	COTR I5	Initialization option number: If IOP.EQ.1,2,3 the input profile is the starting profile. If IOP.EQ.4,5,6,7, the starting profile is calculated using the input profile as a rough guess. If IOP.EQ.1, the starting flow is laminar and $(dU/dx)_\delta 2/\nu_\infty$ is known. If IOP.EQ.2, the starting flow is turbulent and $\delta^*(dp/dx)\ \tau_W$ is known. If IOP.EQ.3, the starting flow is turbulent and $(dU/dx)\delta^*/U$ is known. If IOP.EQ.4, the starting flow is similar laminar. Only on this option do calculations start from the beginning of the boundary layer growth. If IOP.EQ.5, the starting flow is laminar and $(dU/dx)\delta^{*2}/\nu_\infty$ is known. If IOP.EQ.6, the starting flow is turbulent and $\delta^*(dp/dx)/\tau_W$ is known. If IOP.EQ.7, the starting flow is turbulent and $(dU/dx)\ \delta^*/U$ is known.
6	MOP	COTR I5	Designated options on the $g'(\eta)$ profile. The option number is determined from the desired method of obtaining the $g'(\eta)$ profile whether the flow properties are variable or not (see table III).
11	DOP	COTR I5	Controls the interpretation of either the input velocity or the Mach number input data. The option number is determined from table IV.

ORIGINAL PAGE IS
OF POOR QUALITY

Flow properties		Method of obtaining $g'(\eta)$ profile
Not variable	Variable	
-1	1	h^o assumed constant and equal to h_e^o throughout the layer: $g'(\eta) = 0.0$.
-2	2	$g'_w = GBC = \left[h_e^o - h_w(x)\right]/\left(h_e^o - h_r\right)$ is the wall boundary condition imposed on the energy equation.
-3	3	$g''_w = -(GBC)d_w/T_w = -\underset{\sim}{S}_{tr}d_w/T_w$ is the wall boundary condition imposed on the energy equation where $\underset{\sim}{S}_{tr} = R_L S_{tr} = Lg_w/\left[\rho_e \nu_\infty \left(h_e^o - h_r\right)\right]$ for laminar similarity starting solutions and $\underset{\sim}{S}_{tr} = S_{tr} = g_w/\left[\rho_e U \left(h_e^o - h_r\right)\right]$ for all others.

TABLE III. ALTERNATIVE VALUES OF MOP

Interpretation of input $U_{in}(I)$		Interpretation of input, $f'_{in}(\eta)$ profile
Mach number input, ${}^aU_{in}(I) \to M(I)$	Velocity input, ${}^aU_{in} \to U(I)$	
-1	1	${}^af'_{in}(\eta) \to (U - u)/U$ $V_{w_{in}} = V_w$
-2	2	${}^af'_{in}(\eta) \to (\rho_e U - \rho u)/(\rho_e U)$ $V_{w_{in}} = (\rho_w/\rho_e)/V_w$

[a]These interchanges take place at the beginning of the program and thereafter U(I) and $f'(\eta)$ have their conventional meanings, whereas VW(I) represents $(\rho_w/\rho_e)V_w$ throughout the calculation for DOP = ±2.

TABLE IV. ALTERNATIVE VALUES OF DOP

16	IO	COTR I5	Determines type of flow: IO.EQ.-1 for axisymmetric flow on inside surface formed from radii drawn from body axis. IO.EQ.1 for axisymmetric flow on outside surface formed from radii drawn from body axis. IO.EQ.0 or blank for planar flow.
21	TOP	COTR I5	If TOP.EQ.1, transition is to be calculated by the program.
26	POP	COTR I5	Print option for listing data. If TOP.EQ.1, skip detailed list of output.

V-15 CASE INITIALIZATION CARD (8F10.5)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	MR	COTR F10.5	Reference free-stream Mach number generally equal to the potential flow Mach number at start of boundary layer calculation: If IOP.EQ.4, MR=M(2), and if IOP.NE.4, MR=M(1). If IOP.EQ.7 and M(1).EQ.0.0, MR is reset to 0.001.
11	DT(1)	COTR F10.5	Displacement thickness at start of boundary layer calculation: If IOP.EQ.7 and DT(1).EQ.0.0, DT(1)=0.001 in the program.
21	RDT(1)	COTR F10.5	Reynolds number based on displacement thickness at the start of the boundary layer calculation: If IOP.EQ.4, RDT(1) becomes $(x_2-x_1)U(x_2)/$ and can be calculated in the program (see WSTO(3) input).
31	BS	COTR F10.5	Input for initial pressure gradient: If IOP.EQ.1, BS is $(du/dx)\delta^{*2}/\nu_\infty$. If IOP.EQ.2, BS is $\delta^*(dp/dx)/\tau_W$. If IOP.EQ.3, BS is $(du/dx)\delta^*/U$.

6			If IOP.EQ.4, BS=1.0 for Falkner-Skan stagnation point flow and BS=0.0 for Blasius flat plate flow. If IOP.EQ.5, BS is $(dU/dx)\delta^{*2}/\nu_\infty$. If IOP.EQ.6, BS is $\delta^*(dp/dx)/\tau_d$. If IOP.EQ.7, BS is $(dU/dx)\delta^*/U$.
41	TO	COTR F10.5	Free-stream total temperature in degrees Kelvin.
51	BH	COTR	Enthalpy ratio, $(h_e^0 - h_r)/h_e^0$.
61	FT	COTR F10.5	Free-stream turbulence, fraction of time during which the flow at a given position remains turbulent.

V-16 STATION DATA CARD (8F10.5) (Read only if ISTO(15) ≠ 0)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	X	COTR F10.5	Wall station locations (see Special Instructions for Preparing Input section).
11	U	COTR F10.5	Free-stream velocity corresponding to each x-location. The arrays of X(I), U(I), etc., are specified along the boundary surface for the downstream calculations. The maximum number of x-stations that can be computed is 99. The last station data card should be followed by an x-card with an x less than the previous x to switch out of the card read loop.
21	TURB	COTR F10.5	Indicates fraction of flow that is turbulent. For laminar flow, TURB(I)=0.0; for turbulent flows, TURB(I)=1.0. By changing TURB(I) from 0.0 to 1.0, either abruptly or gradually over a distance of several x-stations, the effect of transition can be simulated. Also see WSTO(13).

			If the transition option is used (i.e., TOP.=.1), a TURB(I) input is not needed.
			If flow is all laminar, TURB(I) input is not needed.
			If flow is turbulent, set TURB(I)=1.0 at desired X(I) location.
			All other TURB(I) at locations GT.X(I) will be set to 1.0 by the program.
31	GBC	COTR F10.5	Wall boundary condition on the energy equation, either g'(wall) or g"(wall).
41	RW	COTR F10.5	Radius of body surface in the same units as x.
			If IO=0, RW=0.0.
51	VW	COTR F10.5	Transpiration velocity in the same units as U.
61	SW	COTR F10.5	Nikuradse sandgrain roughness scale in the same units as x.
71	CW	COTR F10.5	Longitudinal wall radius of curvature in the same units as x (if convex cw < 0; if concave cw > 0).

Special Instructions for Preparing Input

Specification of profiles. - The input intervals of η are subdivided by the input JDIV. For a laminar calculation the η step need not vary appreciably across the layer, and the product of JY and JDIV equal to 150 is usually adequate to define a profile. However, in a turbulent portion of the x-profiles a smaller step size should be prescribed close to the wall than is specified further out to improve the accuracy in the "law-of-the-wall" region. The η step size although variable from wall to boundary layer edge, remains fixed throughout the boundary layer calculations. The input step sizes should be specified for accurate results in both laminar and turbulent portions of the flow. The outer edge of the boundary layer in the η coordinate will not change appreciably as the calculations proceed downstream since η is normalized with δ^*. Smaller η spacing will be required throughout the layer if a very small x step is used.

The specifications of the $f'(\eta)$ and $g'(\eta)$ profiles depends on whether these profiles are used as the starting profiles or the input profiles are recalculated. If the input profiles are to be used as specified, they should be compatible with the initial pressure gradient. For turbulent flow the profiles must be well defined in the "law-of-the-wall" region. This region can often be specified by using some empirical "law of the wall". If the input profiles are recalculated, the initial profiles need not be very accurate since the calculated profiles usually converge very rapidly to their final value for almost any reasonable input profile.

Specification of x-step size. - The sequence of the x-values defines the x-spacing at which calculations will be performed. The x-step size depends on the input station Mach number or velocity distribution. The x-step size should be inversely proportional to the magnitude of the slope of the velocity distribution. For large velocity gradients the x-steps must be very small.

The x-step size is most sensitive at the start of the boundary layer growth. However, if the slope of the U(X) as a function of x curve is linear, larger x-step sizes can be taken. The input options ISTO(8) and ISTO(9) can be used to modify input x-station data to include a linear section at the start of the boundary layer growth.

If the program is run separately, or if VAPE is started in VISCOUS by the user, the x-step size and corresponding velocity profile can be specified by the user with the card input. Otherwise, subroutine TRANS will automatically input the step size and velocity gradient as printed out at the end of COMBYN.

2.4 THREE DIMENSIONAL JET PROGRAM**

HESS POTENTIAL FLOW PROGRAM

H-1 TITLE CARD (8A10.0)

COLUMN	CODE	ROUTINE FORMAT		EXPLANATION
1	TITLE	HINIT 8A10		Title of input case

H-2 CASE CONTROL CARD (A5,8I5)

COLUMN	CODE	ROUTINE FORMAT		EXPLANATION
1	CASE	HINIT A5		Case identifier
6	INOPT	HINIT		If INOPT >_ 0 set case = reads
		I5		Read jet data from previous run subroutine JETOLD
			=-1	wooler jet method used
			=-2	Weston jet method used
			<-2	Thames rectangular jet
11	IEXEC	HINIT I5	=0 =1	Partial execution (used to verify input) Full execution
			=-1	Jet calculations only (not checked out)
16	MPR	HINIT I5	=0	No matrix print*
			=1	Matrix printed
21	NGPS	HINIT I5		Number of ground plane sections. Ground plane sections must be first non-lifting sections input
26	JET	HINIT I5		Number of independent jet systems (A jet system contains 1 or more jets)
31	L20	HINIT I5	=0	Panel data written on NT 20 except for sections with X7RPRN non blank
			>0	Panel data written on output unit
			<0	No panel data written on output file* regardless of XTRPRN flag

** The control parameter normally used are denoted by an asterik (*).

36	L21	HINIT I5	=0	JET (wooler) print is or NT 21
			=1	JET (wooler) print for final iteration only is on output file *
			>1	All JET (wooler) print is on output file
41	L22	HINIT I5	=0	Pressures and panel loads are written on NT 22 except for sections with XTRPRN non-blank
			>0	Pressures and panel loads written on output unit *
46	BL	HINIT I5	≤0	No viscous solution
			=1	Viscous solution generated

H-3 <u>CONTROL CARD FOR SECTION INPUT (16I5)</u>

COLUMN	CODE	ROUTINE FORMAT		EXPLANATION
1	NLSEC	HINIT I5		Number of non-lifting sections
6	LIFSEC	HINIT I5		Number of lifting section ≤ 12
11	LASWAK	HINIT I5	=0	Semi-infinite wake not used (See Volume I Section 4.0)
			=1	Semi-infinite wake used* (See Volume I Section 4.0)
16	NOFF	HINIT I5		Number of off body points
21	IG	HINIT I5		Ignored panel flag (for panels which are not exposed to the flow field) i.e. wing panels under pylons, etc.
			=0	All panels used*
			=1	Some panels ignored (Panels defined will be removed from solution matrix.)
26	MOMENT	HINIT I5		Moment origin input flag
			=0	No moment center input
			=1	Moment center coordinates input
31	NSYMI	HINIT I5		X-Z symmetry flag
			=0	No symmetry
			=1	Symmetry in X-Z planes

41	INLETS	HINIT I5	Number of inlets to be input
46	INLVEL	HINIT I5	Inlet velocity input flag ≤0 One inlet velocity per inlet input. This velocity used at all inlet control point. >0 Inlet velocities determined in inlet analysis routine at all inlet control points

NOTE: NLSEC + LIFSEC + INLETS ≤ 24

H-4 REFERENCE DATA CARD (8F10.0)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	REFA	HINIT F10.0	Reference area for force coeff. (Normally wing area)
11	SPAN	HINIT F10.0	Reference span for moment coeff. (Normally wing span)
21	CBAR	HINIT F10.0	Reference length for moment coeff. (Normally wing mal)

H-5 MACH NUMBER CARD (8F10.0)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	AM	HINIT F10.0	Input free stream mach no.

H-6 ANGLE OF ATTACK CONTROL CARD (16I5)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	IATACK	HINIT I5	Number of angle of attack cases to be input ≤ 10

H-7 ANGLE OF ATTACK CARDS (8F10.0)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	ALPHA(1)	HINIT F10.0	Angle of attack No. 1 (Input in degrees)
11	PSI (1)	HINIT F10.C	Angle of yaw No. 1 (nose left is positive)

21	ALPHA(2)	HINIT F10.0	Angle of attack No. 2
31	PSI (1) etc	HINIT F10.0	Angle of yaw No. 2

Input IATACK valves of ALPHA and PSI

H-8 MOMENT REFERENCE CARD (8F10.0) (INPUT ONLY IF MOMENT ≠ 0)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	ORIGNX	HINIT F10.0	X coordinate of moment center
11	ORIGNY	HINIT F10.0	Y coordinate of moment center
21	ORIGNZ	HINIT F10.0	Z coordinate of moment center

H-9 CONTROL CARD FOR NON-LIFTING PANELS (16I5)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	NLSTR(1)	HINIT I7	Number of strips in non-lifting section No. 1
6	NLSOR(1)	HINIT I5	Number of panels per strip in nonlifting section No. 1
11	NLSTR(2)		
16	NLSOR(2)		
	etc		

Input NLSEC values of NLSTR and NLSOR (NLSOR ≤ 99)

H-10 CONTROL CARD FOR LIFTING PANELS (16I5)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	IXFLAG(1)	HINIT I5	Extra strip flag for lifting section No. 1 - This defines a strip of elements which are completely enclosed within another body. No boundary conditions or sources are solved for on the elements of this strip.

= 0 no extra strip input
= 1 first strip is extra
= 2 first and last strips are extra
= 3 last strip is extra

6	NSTRIP(1)	HINIT I5	Number of strips in lifting section No. 1 (includes extra strips)
11	NSORCE(1)	HINIT I5	Number of source panels per strip in section No. 1 (does not include wake panels)
16	NWAKE(1)	HINIT I5	Number of wake panels per strip in lifting section No. 1.
21	IXFLAG(2)	HINIT I5	
26	NSTRIP(2)	"	
31	NSORCE(2)	"	
36	NWAKE(2)	"	

etc

Input lifsec values of IXFLAG, NSTRIP, NSORCE and NWAKE

NOTE: NSTRIP (I) ≤ 20 and NSORCE (I) + NWAKE (I) ≤ 99

H-11 CONTROL CARD FOR IGNORED PANELS (16I5) (INPUT ONLY IF IG >0 AND LIFSEC >0)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	IG1(I,J)	HINIT I5	First ignored panel on lifting strip I
6	IGN(I,J)	HINIT I5	Last ignored panel on lifting strip I
11	IGI(I,J)	"	
16	IGN(I,J)	"	

etc

Repeat for J=1, LIFSEC, I=1, NSTRIP(J)

H-12 CONTROL CARD FOR INLET GEOMETRY (16I5)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	NLSTRK(K)	HINIT I5	Number of strips in inlet section K

6	NLSOR(K)	HINIT I5	Number of panels per strip in inlet section K

Repeat for K = 1, Inlets

H-13 GEOMETRY COORDINATE INPUT CARD NO. 1 (6F10.0, 2A10)

This card reads in first card of each section with appropriate identifiers

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	XB(1)	INPUT* F10.0	X Coordinate of point 1 of given section
11	YB(1)	INPUT F10.0	Y Coordinate of point 1
21	ZB(1)	INPUT F10.0	Z Coordinate of point 1
31	XB(2)	INPUT F10.0	X Coordinate of point 2
41	YB(2)	INPUT F10.0	Y Coordinate of point 2
51	ZB(2)	INPUT F10.0	Z Coordinate of point 2
61	SEC ID	INPUT A10	Section identifier
71	XTRPRN	INPUT A10	Print flag

H-14 GEOMETRY COORDINATE INPUT CARDS NO. 2 (6F10.0)

These cards read in the rest of coordinates for each section

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	XB(I)	INPUT* F10.0	X Coordinate of point I
11	YB(I)	INPUT F10.0	Y Coordinate of point I
21	ZB(I)	INPUT F10.0	Z Coordinate of point I

NOTES: The geometry coordinate input card no. 1 is input at the first of each section followed by the geometry coordinate input cards no. 2. The number of no. 2 cards input depend on the number of panels and strips in each section.

The geometry coordinate cards are input for each section for nonlifting, lifting, and inlet sections in the following required order:

- o All nonlifting sections
- o All lifting sections
- o All inlet sections

*The above geometry cards are read in subroutine LSTINP which is called by subrouting HINIT. The data is read from unit 5 (input on cards, tape) in an 8A10.0 Format and transferred to unit 14 for use in the rest of the program, (subroutine input).

H-15 OFF BODY GEOMETRY INPUT (6F10.0) (Read only if NOFF >0)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	XC(I)	INPUT* F10.0	X Coordinate of off-body pt
11	YC(I)	INPUT F10.0	Y Coordinate of off-body pts
21	ZC(I)	INPUT F10.0	Z Coordinate of off-body pts
31	XC(I+1)	INPUT F10.0	X, Y, Z Coordinates
41	YC(I+1)		
51	ZC(I-1)		

Repeat until NOFF coordinates are input

*See Note Directly Above

H-16 INLET VELOCITY CARDS (6F10.0)

(Input only if inlets >0 and INLVEL ≤ 0)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	VINLET	FCOM F10.0	Inlet Velocity Ratio VINLET/V_∞

Repeat this card for each angle of attack and each inlet

H-17 INLET VELOCITY CARDS (8F10.3) (Input only if INLETS >0 and INLVEL >0)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	YCENT	INLINT F10.3	Y Location of Center of inlet circle
11	ZCENT	INLINT F10.3	Z Location of Center of inlet circle

WESTON JET METHOD

W-1 JET CONTROL CARD (16I5) (Read only if Jet >0 and INCPT = -2)

COLUMN	CODE	ROUTINE FORMAT		EXPLANATION
1	NJ	INPUTW I5		Control flag for α of jets NJ = 1 1 jet NJ = 2 2 jets
6		INPUTW I5		Control flag for wake calculation = 0 wake calculation used (only good for α = 0) = 1 wake calculation ignored

W-2 WESTON CONTROL CARD (8F10.3) (Read only if Jet > 0 & INOPT = -2)

COLUMN	CODE	ROUTINE FORMAT		EXPLANATION
1	VINF	INPUTW F10.3		Free stream velocity, V_∞, FT/SEC
11	XMAX	INPUTW F10.3		Max value of X/D in jet centerline and vortex path. (End of jet should be aft of configuration)
21	DXGT	INPUTW F10.3		Growth parameter used in jet centerline and vortex path.
31	DEXTAX	INPUTW F10.3		Initial stepsize of jet ΔX/D.
41	ZGP	INPUTW F10.3		Ground plane Z coordinate
51	GPI	INPUTW		Control flag for STO calculation
			$\neq$ 0.0	Wall jet calculated
		F10.3	= 0.0	No wall jet calculations

W-3 WESTON JET IDENTIFICATION CARD (Jet 1) (8F10.3) (Read only if Jet > C & INOPT = -2)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	R	INPUTW F10.3	Jet to free stream velocity ratio Vj/V_∞ .
11	PHI	INPUTW F10.3	Jet exhaust angle relative to Y-Z plane (Jet 1)
21	PSI	INPUTW F10.3	Jet exhaust angle relative to X-Z plane (Jet 1)

31	XJ	INPUTW F10.3	X location of Jet 1
41	YJ	INPUTW F10.3	Y location of Jet 1
51	ZJ	INPUTW F10.3	Z location of Jet 1
61	DIAJ(1)	INPUTW F10.3	Diameter of jet exit (use consistant units)

W-4 <u>WESTON JET IDENTIFICATION CARD (Jet 2) (8F10.3) (Read only if Jet >0, INOPT = -2, NJ >1)</u>

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION	
1	RR(2)	INPUTW F10.3	See R above	
11	PHI(2)	INPUTW F10.3	See PHI above	
21	PSI(2)	INPUTW F10.3	See PSI above	
31	XJ(2)	INPUTW F10.3	See XJ above	All for Jet exit no. 2
41	YJ(2)	INPUTW F10.3	See YJ above	
51	ZJ(2)	INPUTW F10.3	See ZJ above	
61	DIAJ(2)	INPUTW F10.3	See DIAJ(1) above	

Note: Cards W-1, W-2, W-3 and W-4 must be input for each angle of attack and for each jet system i.e. number of sets of W-1 through W-4 = Jet x IATACK. (Jet is from card H-2 and IATACK is from card H-6).

WOOLER JET METHOD

WO-1 **WOOLER CONTROL CARDS NO.1 (4I10, 4A10)**

Read only if J>0
and Inopt = - 1
and NJets = 1 (1st Jet)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	MULT	JET3IN I10	Number of jets in configuration mult = 1 on 2
11	IGEOM	JET3IN I10	Not used by this version of code
21	NPS	JET3IN I10	Number of integration intervals per jet segment 3 $\leq$ NPS $\leq$ 10
31	NOIT	JET3IN I10	Number of iterations to be performed on mutual interference velocities between jets Iter = 2 normally (See Ref. 4-2, pp. 18-20) (Leave blank mult = 1)
41-80	SUBTITLE	JET3IN 4A10	Additional title for this particular case

WO-2 **WOOLER CONTROL CARD # 2 (4I10)**

Read only if J>0,
IN OPT = -1 and
NJet > 1 (2nd Jet)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	MULT	JET3IN I10	See above
11	IGEOM	JET3IN I10	
21	NPS	JET3IN I10	
31	NOIT	JET3IN I10	

WO-3 WOOLER JET DATA CONTROL (I10, 7F10.5) Read only if MULT > 0

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	N	JET3IN I10	Number of intervals to be used in the numerical integration of the jet center line, N $\leq$ 100
11	GS	JET3IN I10	Interval size to be used in the intergration of the jet center line as fraction of leading jet diameter
21	SIGH	JET3IN F10.5	Yaw Angle Degrees
31	THETA	JET3IN F10.5	Pitch Angle Degrees
41	FEE	JET3IN F10.5	Roll Angle Degrees
51	YGP	JET3IN F10.5	Height Above Ground, FT

WO-4 WOOLER JET NO. 1 DEFINITION (8F10.0) Read only if MULT > 0

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	XJ1(1)	JET3IN F10.0	X location of jet 1 exit
11	YJ1(1)	JET3IN F10.0	Y location of jet 1 exit
21	ZJ1(1)	JET3IN F10.0	Z location of jet 1 exit
31	PHID(1)	JET3IN F10.0	Jet 1 exhaust angle ϕ deg
41	PSID(1)	JET3IN F10.0	Jet 1 exhaust angle Ψ deg
51	DJET(1)	JET3IN F10.5	Jet 1 exit diameter
61	VELJI(1)	JET3IN F10.0	Freestream to jet exhaust velocity Ratio, Jet no. 1
71	FAN(1)	JET3IN F10.0	This option not checked out.

WO-5 WOOLER JET NO. 1 MIXING VALVES (8F10.0)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	A1	JET3IN F10.0	Ratio of effective core diameter to jet exit diameter for annular or vaned nozzles. (For uniform jet set = 1.0.
11	B1	JET3IN F10.0	Jet mixing parameter for annular or vaned nozzles. (see Ref. 4-2 for details)

WO-6 WOOLER JET NO. 2 DEFINITION (8F10.0) (Read only if mult >1)

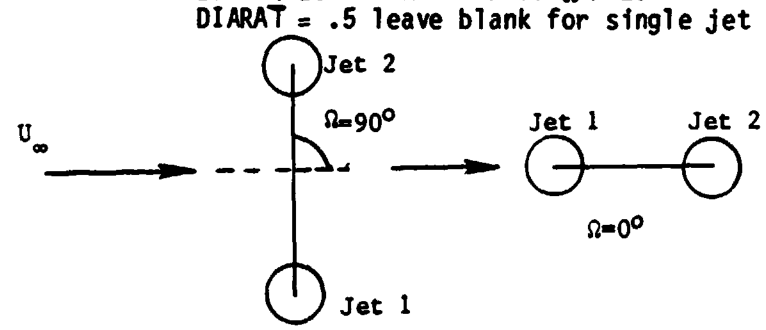
COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	XJ2(1)	JET3IN	
11	YJ2(1)	F10.0	See Wooler Jet 1 data card above for definitions
21	ZJ2(1)		
31	PHID(2)		
41	PSID(2)		
51	DJET2(1)		
61	[illegible]LJ2(1)		
71	[illegible]N(2)		

WO-7 WOOLER JET #2 MIXING VALVES (8F10.0)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	A2	JET3IN	See A1 and B1 above for definitions
11	B2	F10.0	

WO-8 WOOLER COALESCED JET INPUT (8F10.0)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	DIARAT	JET3IN F10.0	Empirical factor for coalesced jet. If $\Omega < 20^{\circ}$ DIARAT = 1 if $\Omega > 20^{\circ}$ DIARAT = .5 leave blank for single jet



Note: Cards wo-1 through wo-8 must be input for each angle of attack and for each Jet system. i.e. Number of sets of wo-1 through wo-8 = Jet x IATACK. (Jet is from card H-2 and IATACK is from card H-6)

RECTANGULAR JET METHOD

R-1 RECTANGULAR JET CONTROL CARD (16I5)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	ICONFG	RECJET I5	Nozzle configuration specification = 1 blunt = 2 streamwise
6	NSINK	RECJET I5	Number of source/sink lines used in model, 1 $\leq$ NSINK $\leq$ 5
11	SNEGV	RECJET I5	Number of segments into which each vortex curve is divided, $\leq$ 30
16	NSEGS	RECJET I5	Number of segments into which each source/sink line is divided, $\leq$ 15

R-2 RECTANGULAR JET DEFINITION CARD (8F10.3)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	R	RECJET F10.3	Jet-to-freestream velocity ratio
11	DELTAJ	RECJET F10.3	Jet injection angle, degrees (not used)
21	S	RECJET F10.3	Length downstream of jet exit that vortex and source/sink line are to extend, normally 15 to 20 jet diameters.
31	XJ	RECJET F10.3	X Location of jet exit
41	YJ	RECJET F10.3	Y Location of jet exit
51	ZJ	RECJET F10.3	Z Location of jet exit
61	PHI	RECJET F10.3	Jet exhaust angle relative to positive Z axis
71	PSI	RECJET F10.3	Jet exhaust angle relative to X axis

R-2A RECTANGULAR JET NOZZLE CARD (8F10.3)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	DE	RECJET	Jet equivalent diameter $De = \frac{4(Area)}{\pi}$
11	AR	RECJET F10.3	Jet nozzle aspect ratio (length/width)

R-3 SOURCE/SINK STRENGTH INPUT CARD (8F10.3) (Input if nsink >0)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	SIGMA(1)	RECTJET F10.3	Strength of source/sink for source/sink line no. 1
11	SIGMA(2)	RECTJET F10.3	Strength line no. 2
21	SIGMA(3)	"	Strength line no. 3
31	SIGMA(4)	"	Strength line no. 4
41	SIGMA(5) (input NSINK valves)	"	Strength line no. 5

Note: Cards R-1 through R-3 must be input for each angle of attack and for each Jet systemm. i.e. Number of sets of cards R-1 through R-3 = JET x IATACK. (JET is from card H-2 and IATACK is from H-6).

VISCOUS SOLUTION

HV-1 VISCOUS FLOW CONTROL VARIABLES

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	RI	HINIT (BSETUP) Free Format	Reynolds number per foot $R_I = \frac{U_\infty}{\nu}$ ν = kinematic viscosity
	UI	HINIT (BSETUP)	Freestream velocity (ft/sec)
		Free Format	If input as zero, program will use Mach number input to Hess program

HV-2 VISCOUS INPUT CONTROL CARD

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	IDEFLT	HINIT (BSETUP)	= 0 Data input below = 1 Defaults variables
		Free Format	TO: LG15 = 1 LG17 = 0 LG20 = 0 LG32 = 1 TI = 518.67°R SWP = 0 RL = 1/12 KPRINT = 0 ITPTFL = 0 INP2FL = 0 See next card for explanation of these values.

HV-3 VISCOUS CONTROL VARIABLES (1) (Input only if IDEFLT = 0)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	LG15	HINIT (BSETUP) Free Format	Boundary layer method selection = 0 2 dimensional boundary layer equations used. = 1 3 dimensional infinite yawed wing equation used.

	LG17	HINIT (BSETUP) Free Format	Transition intermittency flag = 0 Transition from laminar to turbulent flow is instantaneous. = 1 Transition from laminar to turbulent flow is gradual.
	LG20	HINIT (BSETUP) Free Format	Compressibility flag = 0 Incompressible flow equations solved. = 1 Compressible flow equations solved.
	LG32	HINIT (BSETUP) Free Format	Profile print flag = 0 All boundary layer velocity profiles will be presented. = 1 Print output summary data only. (No velocity profiles will be presented.)

HV-4 VISCOUS CONTROL VARIABLES (2) (Input only if IDEFLT = 0)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	TI	HINIT (BSETUP) Free Format	Free stream temperature, T_∞
	SWP	HINIT (BSETUP) Free Format	Sweep angle in degrees (input only if LG15 = 1)
	RL	HINIT (BSETUP) Free Format	Geometry scale factor. The X-Y coordinates are multiplied by this parameter before calculations are started.

HV-5 VISCOUS CONTROL VARIABLES (3) (Input only if IDEFLT = 0)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	KPRINT	HINIT (BSETUP) Free Format	= 0 Output data from BSETUP defining boundary layer cases suppressed. = 1 All data output from BSETUP.
	ITPTFL	HINIT (BSETUP) Free Format	= 0 Output data from boundary layer routine suppressed. = 1 Output data from boundary layer routine printed.

	INP2FL	HINIT (BSETUP) Free Format	= 0 Input data to boundary layer routine not printed. = 1 Input data to boundary layer routine is printed.

HV-6 VISCOUS TRANSITION LOCATION CARD

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	LG16	HINIT (BSETUP) Free Format	Boundary layer transition location flag. = 0 Transition point is input (station number). = 1 Transition point will be calculated by the Michel method.

HV-7 VISCOUS TRANSITION LOCATION (Input only if LG16 = 0)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	NXT	HINIT (BSETUP) Free Transition	Station number at which flow becomes turbulent. For all laminar flow, set NXT greater than expected number of points. For all turbulent flow, set NXT = 2. Program will not work if NXT set to less than 2.

Note: Input HV-6 and HV-7 (if necessary) for all lifting sections at each angle of attack if ISECT = number of lifting sections. Then input (ISECT)(IATACK) values.

3.0 VAPE INPUT FLOW CHARTS.

This section contains a series of flow charts to assist the user in deciding what cards need to be input for the case in question. The various input cards are explained in Section 2 and card set numbers are assigned for each of the options applicable i.e. E-1 refers to the primarily control card in the executive system section. Each option is presented separately with the first subsection (3.1) indicating which options will be exercised. No attempt is made in this section to show program execution logic or internal data transfer logic.

3.1 MAIN VAPE PROGRAM.

In the VAPE main program control routine (program vape), the input determines which options are to be executed. Since the inlet analysis program consists of a larger number of options, these are also selected in this main routine.

Figure 4-1 presents the main program flow as determined by the input parameters IPROG and IRPG2. As can be seen in the figure IPROG determines the starting option and IPRG2 and to a certain extent IPASS determines the final option. For example, IPROG = 1 and IPRG2 = 7 indicates that the program will perform all options available through the Hess three dimensional program, but does not indicate anything about jet solutions, which will be referenced later. Therefore, if only a three-dimensional Hess solution is desired then IPROG = 7 and IPRG2 = 7. Since the input data required is input within each option, this chart also indicates the input required and the order of the input. For example, if IPROG = 2 and IPRG2 = 7 then the data for the options, ECD, COMBYN, TRANSG, VISCUS, GEOMOD and Hess are required in that respective order.

It should be noted that options 1 through 6 (SCIRCL through GEOMOD) are all inlet analysis options.

3.2 STOCKMAN INLET ANALYSIS SUB-PROGRAM INPUT.

The charts presented in this section are for options 1 throught 6 of the previous section (Figure 3-1). They are input in the order specified on the primary control card. The cards are identified by a card set number as given in section 2.0.

The logic of these charts are indicated in Figure 3-2 by observing that card IA-8 in input in the data set only if ENREED is not equal to -1, 10, or 1. Figure 4-2 shows the logic of input to option number 1 (subroutine SCIRCL).

Figure 3-3 shows the primary logic of the axisymmetric potential flow program data input sequence. The subroutine call to part 1 is where most of the data in input. Subsequently part 1 calls BASIC 1 and BASIC 2 for further input. *Two very important items must be noted in Figure 3-3:*

(1) Card AP-1 has an input quantity NIN, which is the flag to tell the program where the input data is orginating. If NIN = 5 then the data for the potential flow routine must be input on cards. If NIN = 20 then the data will be transferred from subroutine scircl and no data will be input on cards. The normal case is NIN = 20.

(2) If NIN = 5 then two sets of data must be input to the potential flow routine. One for an open ended body and one for a closed ended body. See Reference 3-1 for further information.

The input logic to the combination option of the inlet analysis method is presented in Figure 3-4. The chart is sufficient to indicate the flow if input data to this program.

The next option is the TRANS program which takes data output from the combination routine and translates scales and sets up in correct format for input to the viscous routine.

Since most of the data is transferred internally, only one value on one card is required in this routine as input. Therefore, no logic diagram is presented for this option.

The last option in the inlet analysis program is the viscous option where the boundary layer effects are computed. Again this data input is very straight forward and is explained adequately by Figure 3-5.

3.3 HESS THREE DIMENSIONAL POTENTIAL FLOW PROGRAM.

All of the data required for Hess program including the jet data and viscous data is read in subroutine HINIT and transferred to unit MT14 for use by the various subroutines. Since the data input is easier to understand when placed in the correct logic flow if the program the subroutine names where the data is required (and read from unit MT14) are used as reference. The input to this part of Vape requires some careful planning to make efficient use of the program.

The majority of the expense in a Hess run is the matrix formation and solution. The solution is such that the incorporation of additional right hand sides to the problem, or additional angles of attach are second order as far as computation time is concerned. Therefore it is prudent to run all of the cases that are required at one time. There fore, if multiple angles of attack are input with repeat values, i.e. α =0, 5, 10, 0, 5, 10 etc. then the inlet velocity matrix of values and the jet solutions can be altered to give a complete range of cases. A typical run might consist of 9 angles of attack 0, 5, 10, 0, 5, 10, 0, 5, 10 and three different jet velocity cases with associated inlet velocities. A sample input for such a case is presented in a later section.

The logic flow chart shown in Figure 3-6 should be studied carefully to avoid any problems.

Since the input to the jet and viscous methods are relatively simple and are read from the Hess program, the charts for these routines are presented in this section as Figures 3-7 through 3-10.

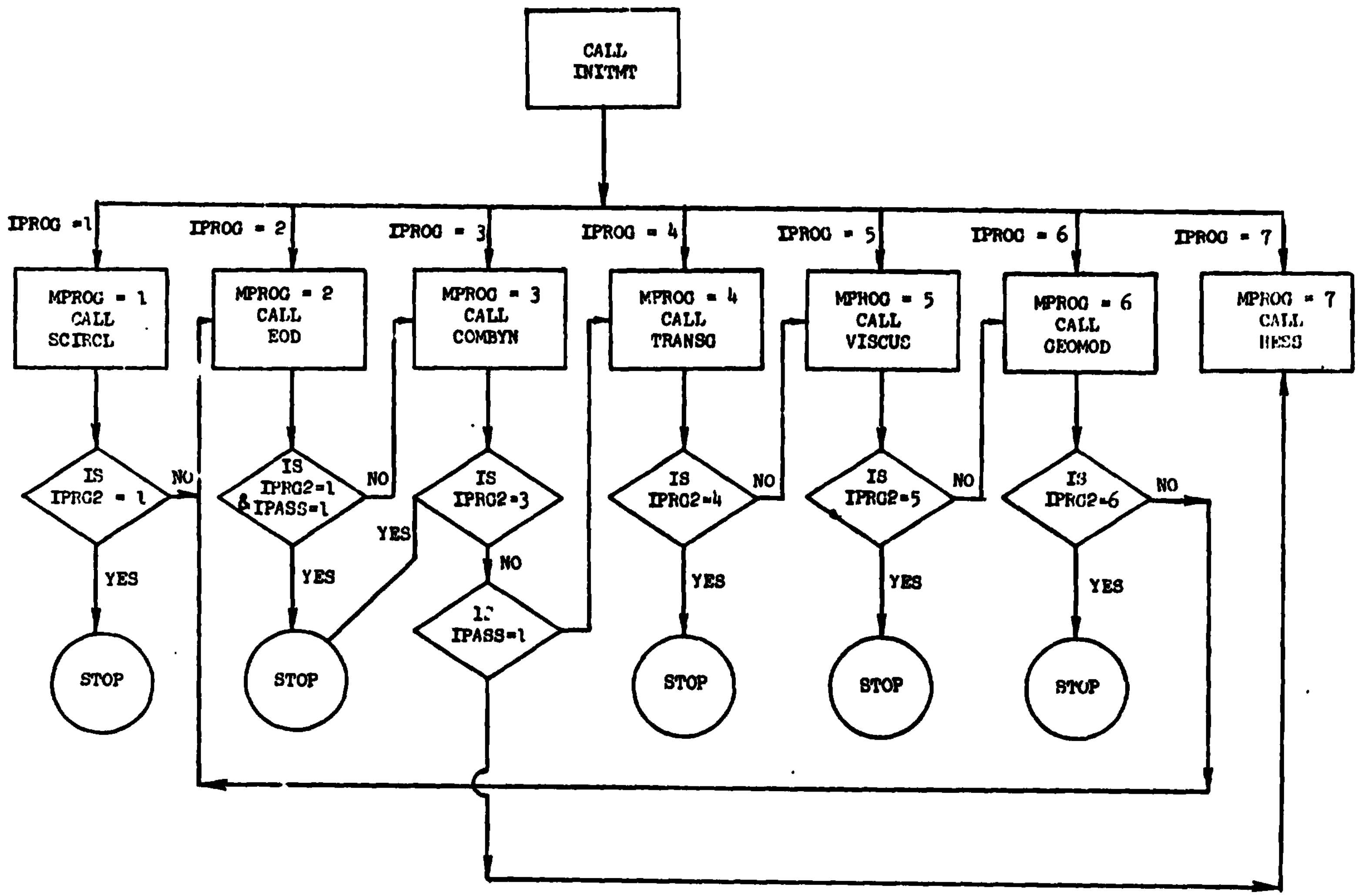


Figure 3-1. Main Program Logic Flow

ORIGINAL PAGE IS OF POOR QUALITY

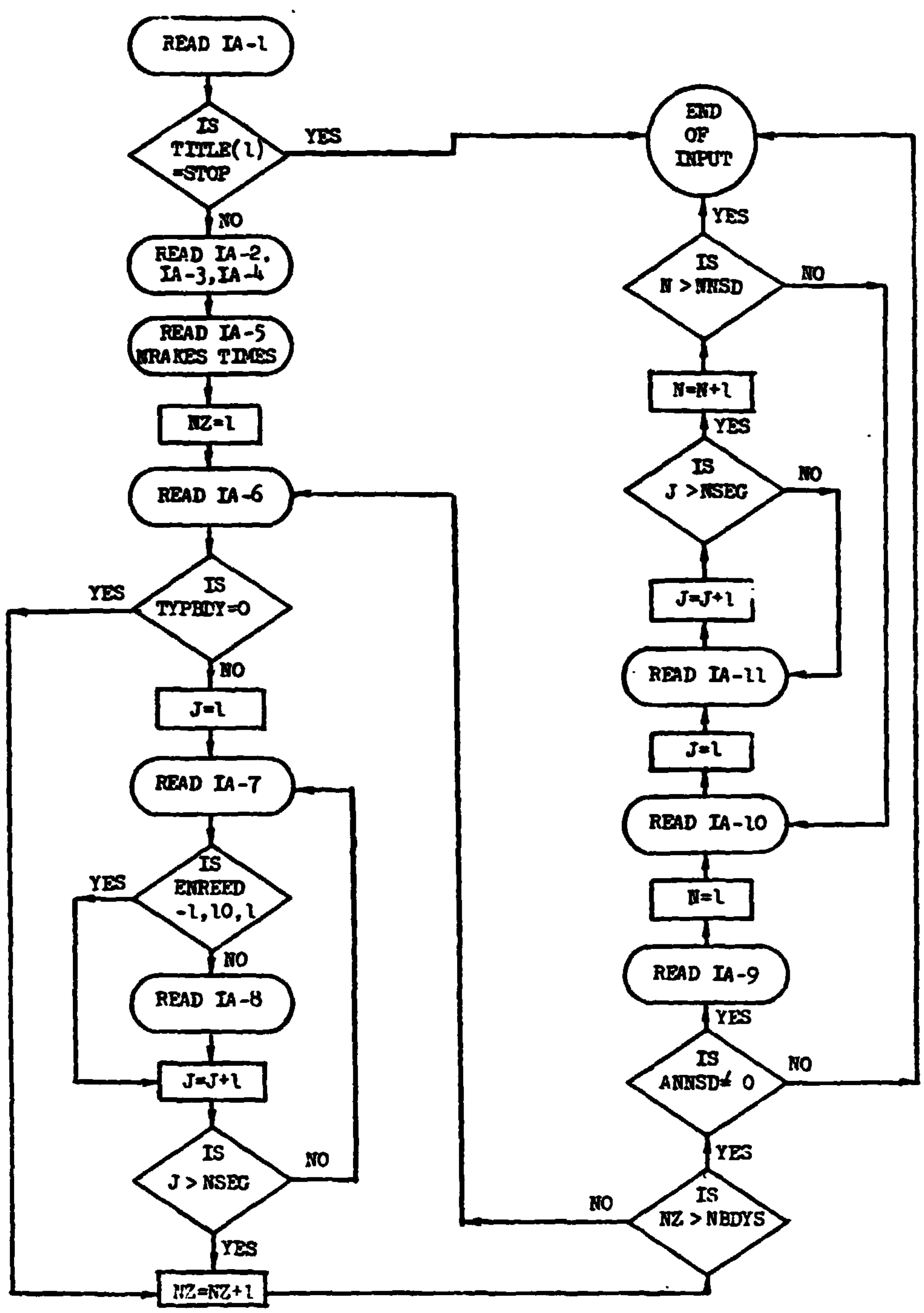


Figure 3-2. Input logic flow for Geometry Module of Stockman's Inlet Analysis Program

ORIGINAL PAGE IS
OF POOR QUALITY

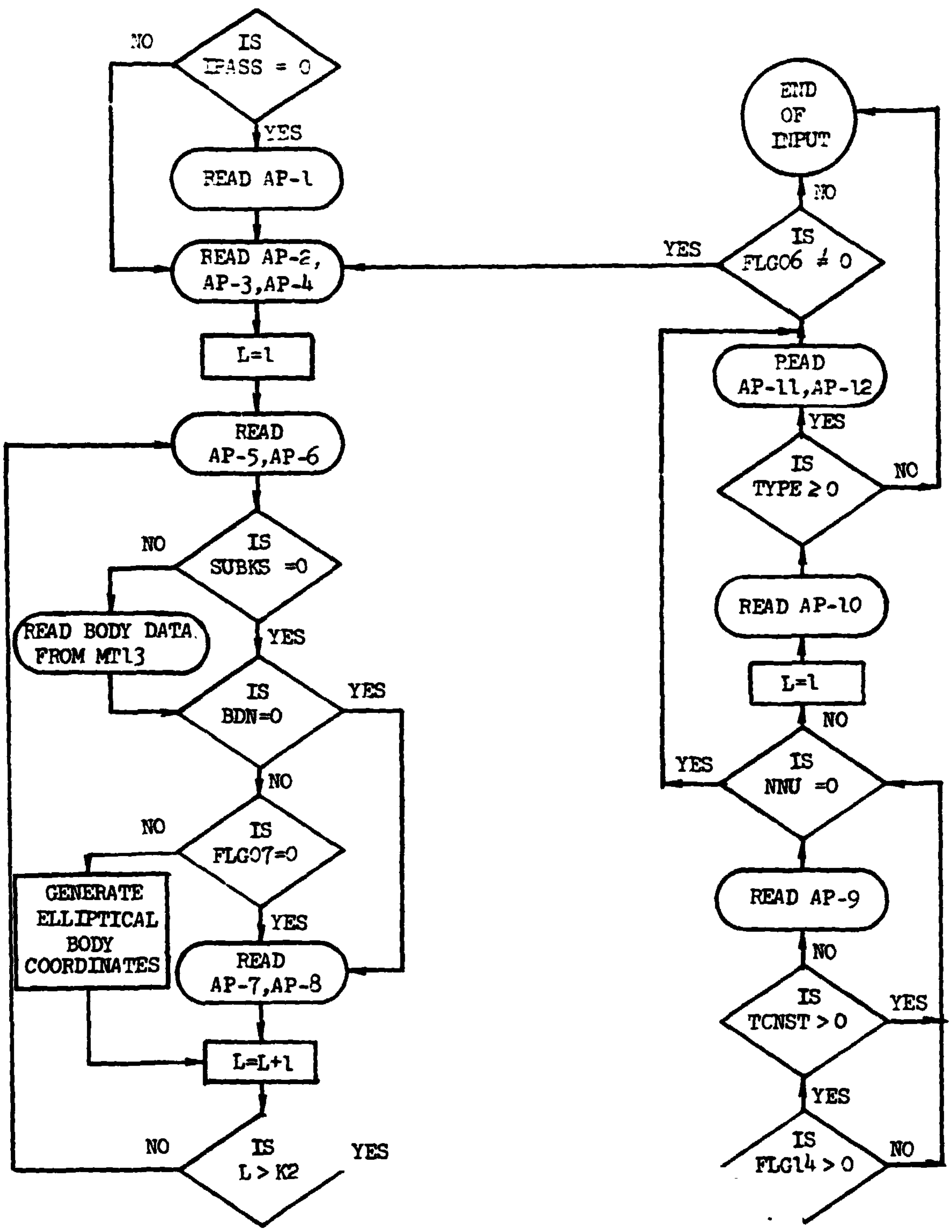


Figure 3-3. Input logic flow for Axisymmetric Potential Flow Module of Stockman's Inlet Analysis Program

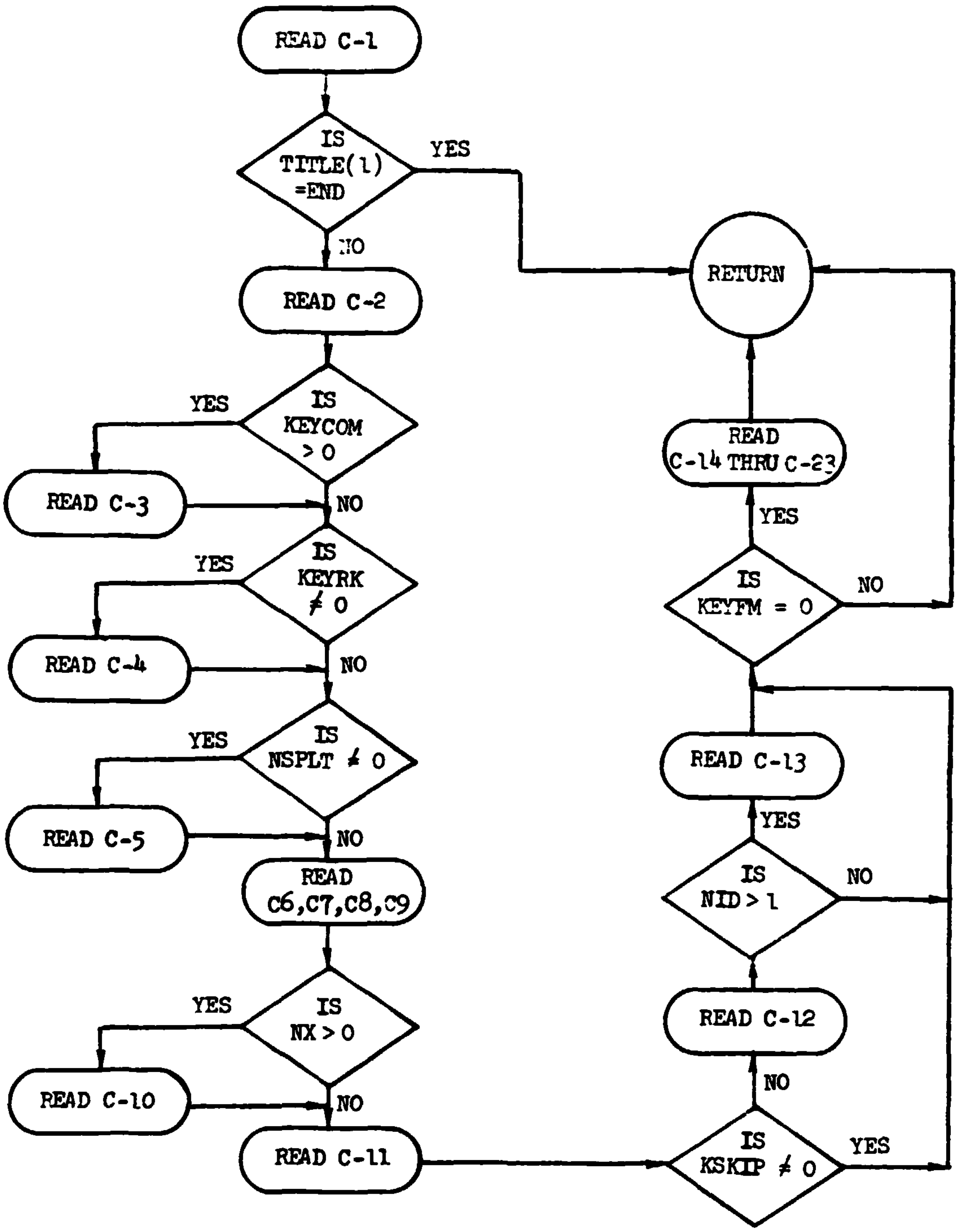
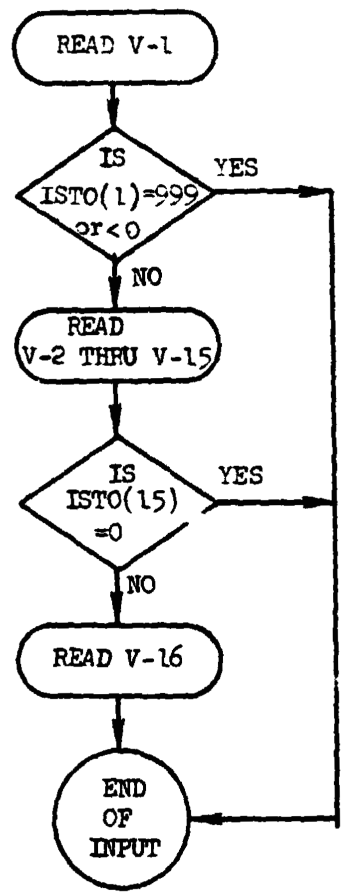


Figure 3-4. Input logic flow for Combination Module of Stockman's Inlet Analysis Program



Note: If ISTO(1) .GE. 0 than cards V-2 through V-15 are input on cards and transferred to Unit 31 for future runs

Figure 3-5. Input logic flow for Viscous Module of Stockman's Inlet Analysis Program

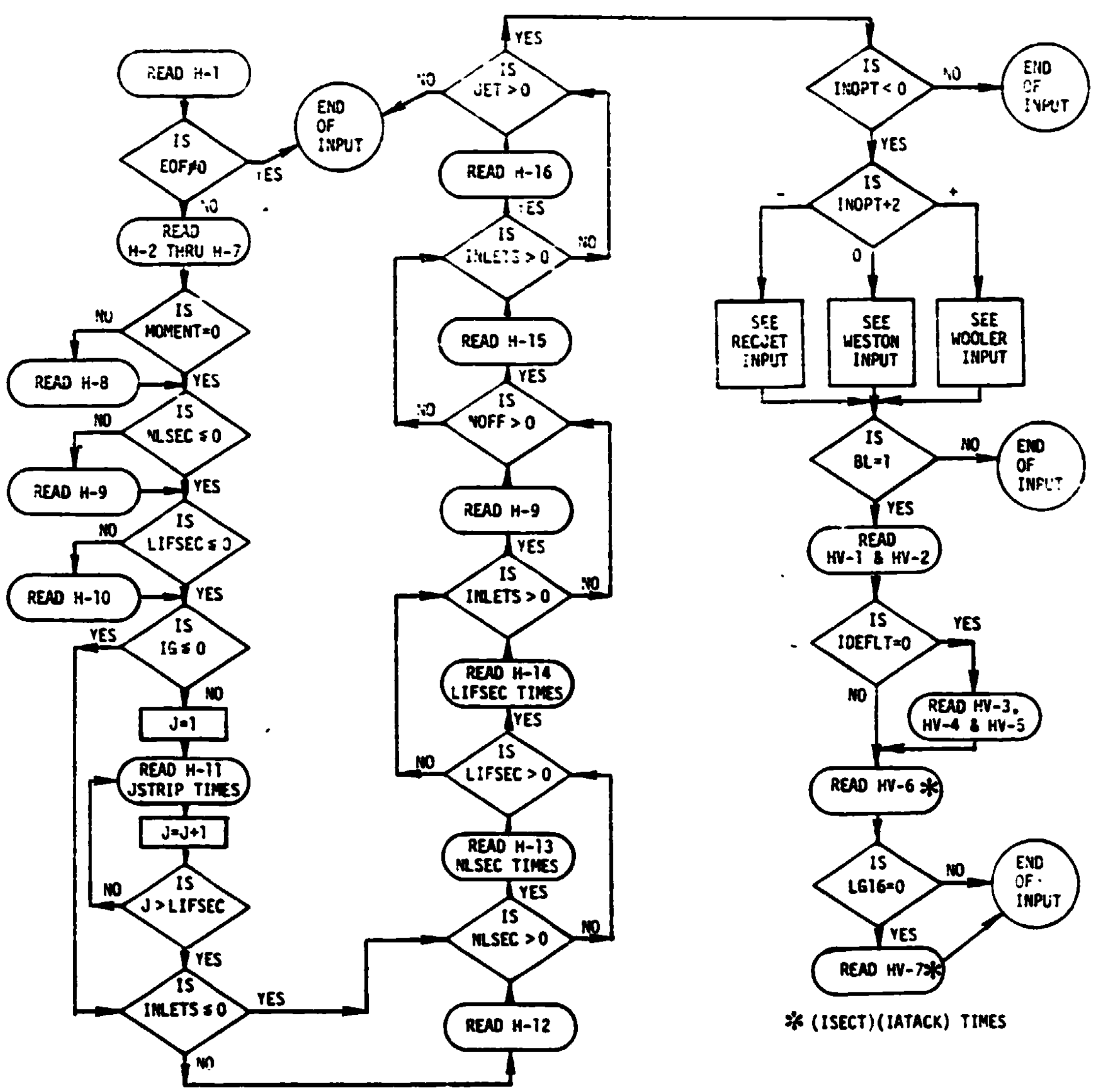


FIGURE 3-6. INPUT LOGIC FLOW FOR HESS THREE DIMENSIONAL POTENTIAL FLOW PROGRAM

ORIGINAL PAGE IS
OF POOR QUALITY

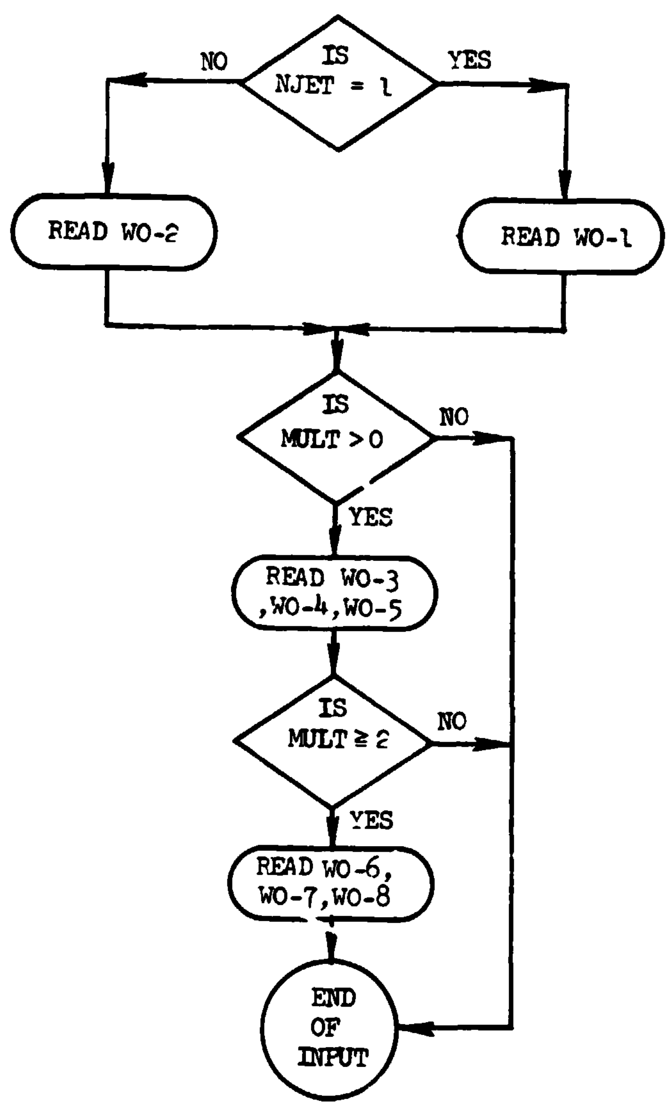


Figure 3-7. Input logic flow for Vought/Wooler Jet Module

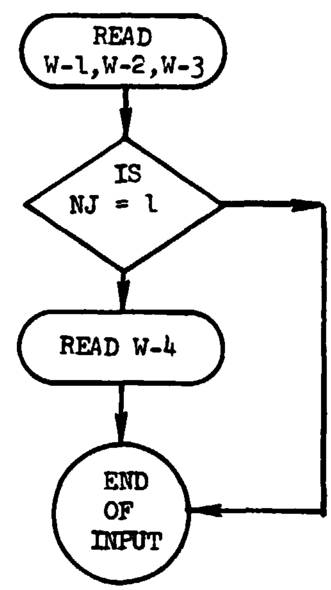


Figure 3-8. Input logic flow for Vought/Weston Jet Module

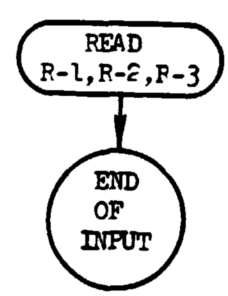


Figure 3-9. Input logic flow for Vought Rectangular Jet Module

4.0 SAMPLE CASE INPUT

4.1 SAMPLE CASE FOR INPUT TO INLET ANALYSIS ROUTINE

This section contains two sample input cases. The first example is representative of the input required to analyze an inlet configuration to determine the inlet separation boundaries. This case, therefore, includes input for the geometry routine, the potential flow routine, the combination routine, and the viscous routine. Note that since the data is transmitted internally from one routine to the next, that only a minimum amount of input is required. For example, only one card is input for the potential flow routine.

The first case is for the QCSEE Inlet using the following data:

$A_{HL}/A_{TH} = 1.37$ 2:1 Ellipse Internal Lip Shape

$D_{HL}/D_M = .905$ α = 40 degrees

V_∞ 90 KTS

```
  1    5      400       690.           0     0.65
 QCSEE AHL/ATH=1.37   2:1 ELLIPSE   DHL/DM=.905
      0      EOC       0
        2.0        .25        1.0     13.615
 3
      16     1.7 P                    4.9
      10     3.70                     5.0
      20     13.615       2.45        5.95
1.0        2.0
           2.0        8.615      -1.0      6.615      3.9
11.615     2.4        35.        2.4
           1.9        11.615     2.4       36.0       2.4
2.0        6.0
           4.0        36.0       6.0       11.615     6.0
           -3.0       13.0       6.0       11.615     6.0      1.702     4.991
1.0        4.991
           2.0        3.0        4.991     1.702      4.931
0.0        5.842      3.0        8.0
           2.266      8.0        4.3       3.0        5.842
2.582      6.475      4.0        6.455
           1.9        2.582      6.455     11.615     6.455
           1.0        11.615     6.455     36.0       6.455
STOP
  20
  3   5        600      600.            0     0.65   213   208   30   40
   QCSEE INLET   AHL/ATH=1.37
    1
0.4        135.       -58.       544.      1.0        0.0       0.0       0.0
2064.      2044.      540.       15.157    .25
    3
0.0        90.        180.
13.615
    052879    1
END
```

INPUT FOR GEOMETRY ROUTINE

INPUT FOR POTENTIAL ROUTINE

INPUT FOR COMBINATION ROUTINE

ORIGINAL PAGE IS
OF POOR QUALITY

```
13.615
   1    1    4    1    1    1    1    0    0    1    1    0    1    1    0
  .9999          300.              5480.        0.              .083333
   0.             0.               1.0          0.              1.0
 .0001564         0.               1.0          .90             .78
   1.0            0.               0.0          0.0             0.0
        OCSEE TEST INLET - GE2     HUB          TURBULENT INPUT PROFILE
   4
  36
0.000     .016      .032      .048      .064      .080
.096      .112      .128      .144      .160      .240
.320      .40       .480      .56       .640      .720
.800      .960      1.120     1.280     1.440     1.600
2.400     3.200     4.000     4.800     5.600     6.400
7.200     8.000     10.       12.       14.       16.
  32
1.00      .5884     .5456     .5185     .4983     .4821
.4684     .4565     .4461     .4367     .4281     .3940
.3683     .3482     .3318     .3161     .3029     .2911
.2803     .2613     .2449     .2303     .2173     .2054
.1500     .1227     .0943     .0704     .0497     .0314
.0149     0.0
  6
0.00      2.0       0.0       0.0       0.0       0.0
  4    1    1    1    1    1
.850      0.0       0.0       1.0       295.23    1.0       1.0
   1    1    4    1    1    1    1    0    0    1    2    0    1    1    0
  .9999          300.              5480.        0.              .08333
   0.             0.               1.0          0.              1.0
 .0001564         0.               1.0          .90             .78
   1.0            0.               0.0          0.0             0.0
        OCSEE TEST INLET - GE2     COWL         TURBULENT INPUT PROFILE
   4
  36
0.000     .016      .032      .048      .064      .080
.096      .112      .128      .144      .160      .240
.320      .40       .480      .56       .640      .720
.800      .960      1.120     1.280     1.440     1.600
2.400     3.200     4.000     4.800     5.600     6.400
7.200     8.000     10.       12.       14.       16.
  32
1.00      .5884     .5456     .5185     .4983     .4021
.4684     .4565     .4461     .4367     .4281     .3940
.3683     .3482     .3318     .3161     .3029     .2911
.2803     .2613     .2449     .2303     .2173     .2054
.1500     .1227     .0943     .0704     .0497     .0314
.0149     0.0
  6
0.00      0.0       0.0       0.0       0.0       0.0
  4    1    1    1    1    1
.12       0.0       0.0       0.0       295.23    1.0       1.0
 999
```

INPUT FOR
BOUNDARY LAYER
ROUTINE

ORIGINAL PAGE IS OF POOR QUALITY

The second example is representative of the input required to analyze an inlet configuration to determine the forces and moments acting on the inlet. This case, therefore, includes all of the input data contained in Case 1, with additional input data added for the force and moment program.

This case is also for the QCSEE Inlet using the following data:

A_{HI}/A_{TH} = 1.46 2:1 Ellipse Internal Lip Shape

D_{HI}/D_M = .905 α = 70 degrees

M_{TH} = .70 V = 75 KTS

INPUT FOR GEOMETRY ROUTINE

```
   1    5      400      610.           .352
     QCSEE  AHL/ATH=1.46   2:1 ELLIPSE   DHL/DM=.905
         0      END      0
        2.0       .25       1.0       14.0
     3
        10       2.396      0.0       4.9
        16       4.396      0.0       5.0
        16       1.433      2.45      5.95
   1.0       2.0
             2.0       0.439     -1.0      0.429     6.0
   12.039    2.6       36.0      2.4
             1.0       12.039    2.4       36.0      2.40
   2.6       6.0
             1.0       36.0      6.0       12.039    6.0
             -3.0      13.0      6.0       12.039    6.0       2.395    4.991
   1.0       4.391
             2.0       3.0       4.991     2.496     4.991
   0.6       6.039     0.0       0.0
             2.246     0.0       5.0       0.0       6.039
   2.251     5.673     4.0       6.673
             1.0       2.251     6.673     12.039    6.673
             1.0       12.039    6.073     36.0      6.073
   STOP
```

INPUT FOR POTENTIAL ROUTINE

```
   20
```

INPUT FOR COMBINATION ROUTINE

```
      QCSEE  CR=1.46  TILT NACELLE CASE
    1    6                 1    1
   -.1026    7.456
   2.096
   9.0       127.624   -20.      541.0     1.0       3.0       0.0       0.0
   2.52.3    2044.     540.      23.413    .25
     19
   0.0       10.       20.       30.       40.       50.       50.       70.
   90.       90.       100.      110.      120.      130.      140.      150.
   160.      170.      180.
   140.
     16229    61
   END
```

INPUT FOR BOUNDARY LAYER ROUTINE

```
   14.66
     1    1    4    1    1    1    1    0    0    1    1    0    1    1    0
     .3999           300.              5490.        0.             .033333
      3.              3.                1.6          0.             1.0
     .0001564         3.                1.6          .36            .78
      1.0             0.                0.0          0.0            6.0
          QCSEE TEST INLET - SE2     4UB         TURBULENT INPUT PROFILE
     6
     36
   0.060     .016      .032      .040      .064      .060
   .096      .112      .128      .144      .160      .240
   .320      .40       .480      .56       .64       .72
   .500      .960      1.120     1.280     1.440     1.660
   2.400     3.260     4.030     4.060     5.660     6.400
   7.203     9.063     10.       12.       14.       16.
     32
   1.00      .5804     .5436     .5185     .4962     .4021
```

ORIGINAL PAGE IS
OF POOR QUALITY

```
.4604     .4565     .4451     .4367     .4281     .3940
.3603     .3462     .3310     .3161     .3029     .2911
.2803     .2613     .2449     .2303     .2173     .2054
.1580     .1227     .0943     .0784     .0497     .0314
.3149     0.0
  0
0.00      0.0       0.0       0.0       0.0       0.0
   4    1    1    1    1    1
.050      0.0       0.0       1.0       295.23    1.0       1.0
  1    1    4    1    1    1    1    0    0    1    2    0    1    1    0
   .9999            330.             5400.           3.                .14333
     0.               0.               1.0             0.                1.0
   .0301594           0.               1.0             .99               .70
     1.0              0.               0.0             3.0               0.0
          QCSEE TEST INLET - GE2     CONL        TURBULENT INPUT PROFILE
   .
   35
3.333     .016      .032      .046      .064      .089
.096      .112      .128      .144      .160      .240
.320      .400      .480      .56       .640      .720
.800      .960      1.120     1.280     1.440     1.600
2.400     3.200     4.000     4.800     5.600     6.400
7.200     8.000     10.       12.       14.       16.
   32
1.00      .5684     .5436     .5165     .4983     .4821
.4684     .4565     .4451     .4367     .4281     .3940
.3603     .3462     .3313     .3161     .3029     .2911
.2803     .2613     .2449     .2303     .2173     .2054
.1500     .1227     .0943     .0784     .0497     .0314
.2149     0.0
   6
3.0       0.0       0.0       0.0       0.0       0.0
   4    1    1   -1    1    1
.12       0.0       0.0       0.0       295.23    1.0       1.0
  999

      QCSEE CR=1.46 TILT NACELLE CASE
21        35
   0.0       5.639     -20.0
   .01923    5.939     -5.1962
   .08777    5.753     -1.7536
   .21316    5.587     -1.0415
   .36266    5.441     -.71093
   .57003    5.320     -.52796
   .79320    5.224     -.39026
   1.0216    5.142     -.29360
   1.2556    5.061     -.21958
   1.4936    5.037     -.15353
   1.7336    5.009     -.09799
   1.9750    4.995     -.02355
   2.2210    4.992     .00759
   2.4765    4.996     .02221
   2.7100    5.063     .03594
   2.9656    5.413     .04846
   3.2218    5.627     .06095
   3.4556    5.043     .07225
   3.6966    5.062     .00271
   3.9421    5.160     .09249
   4.1828    5.167     .1014
  0.0        6.039     20.0
  .04328     6.142     2.1259
  .1629      6.294     .60132
  .3318      6.362     .43257
  .5235      6.452     .31028
  .7319      6.500     .23178
  .9435      6.553     .17042
  1.173      6.583     .13317
  1.399      6.615     .10597
  1.627      6.637     .07916
  1.857      6.653     .05521
  2.085      6.663     .03528
  2.326      6.673     .01336
```

INPUT FOR
FORCE AND
MOMENT
ROUTINE

ORIGINAL PAGE IS
OF POOR QUALITY

```
2.553    5.672    0.0507
2.756    5.673    0.0
3.[illegible]29  5.673    0.0
3.[illegible]3   5.673    0.0
3.[illegible]    5.673    0.0
3.72[illegible]  5.673    0.0
3.[illegible]3   5.673    0.0
4.137    5.673    0.0
4.42[illegible]  5.673    0.0
4.034    5.673    0.0
4.667    5.673    0.0
5.121    5.673    0.0
5.3[illegible]   5.673    0.0
5.560    5.673    0.0
5.621    5.673    0.0
6.055    5.673    0.0
5.238    5.673    0.0
5.522    5.673    0.0
5.755    5.673    0.0
5.509    5.673    0.0
7.222    5.673    0.0
7.456    5.673    0.0
     ALPHA=7[illegible].      W=23.419
 SIN PARS=14.192, [illegible]=535.3, VFLIGH[illegible]=128., [illegible]=0[illegible].[illegible], [illegible]CALPHA=78.[illegible]
   SIDSLIP=0.0, S=0.0, L=0.0   5
 90.                19
 11        19       2.[illegible]36
 0.0       .5444    1.0889    1.6333    2.1778    2.7222    3.2667    3.8111
 4.3556    4.900    4.9318
```

4.2 SAMPLE CASE FOR INPUT TO HESS THREE DIMENSIONAL PROGRAM

This is a sample input case for the configuration of Reference 4.1. This case is defined to read in single values of inlet velocity for each subcase to be considered. In this run, a subcase is defined to be one combination of angle of attack, one jet velocity ratio, and one inlet velocity. There are nine (9) subcases defined in this input. The flags are set to run a case with the data for a Vought/Weston jet model. The input data for the jet model are not shown in this listing, but are shown later under the data presented in Section 4.3. The data for the jet models would appear directly before the 999. card shown in the following listing:

```
.     7     7
  TN 0-7191  N1-90  WESTON JET MODEL
  4031     2     1     1     0     1     1     1     1
    12     1     1     0     1     1     1     3     1
  3240.0        40.25        2.35
     0.0
     9
  0.0          0.0          5.0          0.0          10.          0.0          0.0          0.
  5.0          1.0          20.          0.0          0.0          0.0          5.0          0.
  10.          2.0
     3.02        0.0         -2.555
     4    10     1     4     2    15     1     5     1    72     1    10     3     3     1     5
     5     2     3     9     3    13     2    10
     3     9    26     3
     4     8     2     1     2     8     6     6     4     4     5    23     8    20
     3     8
     5     5
    -20.2        0.0         -4.58        -20.2         0.0         -4.58   FUS NOSE
    -20.2        0.0         -4.58        -20.2         0.0         -4.58
    -20.2        0.0         -4.58        -20.2         0.0         -4.58
    -20.2        0.0         -4.58        -20.2         0.0         -4.58
    -20.2        0.0         -4.58        -20.2         0.0         -4.58
    -20.2        0.0         -4.58
    -17.5        0.0         -3.10        -17.5         0.31        -3.14
    -17.5        0.58        -3.30        -17.5         0.78        -3.53
    -17.5        0.93        -3.80        -17.5         0.97        -4.15
    -17.5        0.97        -4.50        -17.5         0.69        -4.81
    -17.5        0.66        -5.08        -17.5         0.39        -5.32
    -17.5        0.0         -5.47
    -13.9        0.0         -1.51        -13.9         0.62        -1.71
    -13.9        1.09        -2.17        -13.9         1.40        -2.64
    -13.9        1.55        -3.26        -13.9         1.63        -3.88
    -13.9        1.63        -4.46        -13.9         1.51        -5.04
    -13.9        1.20        -5.59        -13.9         0.65        -5.94
    -13.9        0.0         -6.01
     -9.9        0.0         -0.16         -9.9         0.93        -0.58
     -9.9        1.51        -1.36         -9.9         1.42        -2.10
     -9.9        1.94        -2.95         -9.9         1.98        -3.88
     -9.9        1.94        -4.73         -9.9         1.82        -5.39
     -9.9        1.47        -5.96         -9.9         0.89        -6.29
     -9.9        0.0         -6.32
     -5.85       0.0          0.54         -5.85        1.20         0.35
     -5.85       2.10        -0.39         -5.85        2.25        -1.55
     -5.85       2.25        -2.72         -5.85        2.25        -3.86
     -5.85       2.25        -5.06         -5.85        2.17        -5.90
     -5.85       1.90        -6.48         -5.85        1.13        -6.56
     -5.85       0.0         -6.56
     -5.85       0.0          0.54         -5.85        1.20         0.35   FUS A
     -5.85       2.10        -0.39         -5.85        2.25        -1.55
     -5.85       2.25        -2.72
     -2.75       0.0          0.54         -2.75        1.20         0.35
     -2.75       2.10        -0.39         -2.75        2.37        -0.85
     -2.75       2.37        -0.85
```

ORIGINAL PAGE IS
OF POOR QUALITY

-5.85	2.25	-2.22	-5.85	2.27	-2.72	NAC FAC PRS
-5.85	3.03	-1.86	-5.85	3.43	-1.16	
-5.85	4.42	-0.62	-5.85	5.51	-0.62	
-5.85	6.52	-1.16	-5.85	7.26	-2.17	
-5.85	7.06	-3.26	-5.85	6.52	-4.27	
-5.85	5.51	-4.01	-5.85	4.42	-4.91	
-5.85	3.49	-4.27	-5.85	3.03	-3.57	
-5.85	2.07	-2.72	-5.85	2.25	-2.72	
-4.70	2.33	-2.03	-4.70	2.49	-2.03	
[illegible]	[illegible]	-1.2[illegible]	[illegible]	[illegible]	[illegible]	
-4.70	4.33	-0.16	-4.70	5.63	-2.15	
-4.70	6.75	-0.78	-4.70	7.53	-1.86	
-4.70	7.53	-3.26	-4.70	6.97	-4.54	
-4.70	5.70	-5.24	-4.70	4.27	-5.24	
-4.70	3.22	-4.66	-4.70	2.75	-4.04	
-4.70	2.48	-3.46	-4.70	2.33	-3.46	
-2.75	2.37	-0.85	-2.75	2.91	-0.55	
-2.75	2.91	-0.85	-2.75	3.34	-0.47	
-2.75	4.27	0.04	-2.75	5.70	0.34	
-2.75	6.67	-0.62	-2.75	7.57	-1.86	
-2.75	7.57	-3.26	-2.75	6.97	-4.54	
-2.75	5.70	-5.24	-2.75	4.27	-5.24	
-2.75	3.22	-4.66	-2.75	3.22	-4.66	
-2.75	3.22	-4.66	-2.75	2.41	-4.66	
-5.85	2.25	-2.72	-5.85	2.25	-3.08	FUS 9
-5.85	2.25	-5.04	-5.85	2.17	-5.96	
-5.85	1.98	-6.48	-5.85	1.13	-6.56	
-5.85	0.0	-6.56				
-2.75	2.41	-4.65	-2.75	2.41	-4.66	
-2.75	2.41	-5.32	-2.75	2.33	-5.96	
-2.75	1.98	-6.56	-2.75	1.39	-6.60	
-2.75	0.0	-6.60				
-2.75	0.0	0.54	-2.75	1.28	0.35	FUS NAC A PR
-2.75	2.10	-0.39	-2.75	2.37	-0.85	
-2.75	2.91	-0.85	-2.75	2.91	-0.55	
-2.75	3.34	-0.47	-2.75	4.27	0.04	
-2.75	5.70	0.04	-2.75	6.87	-0.62	
-2.75	7.57	-1.86	-2.75	7.57	-3.26	
-2.75	6.87	-4.54	-2.75	5.70	-5.24	
-2.75	4.27	-5.24	-2.75	3.22	-4.66	
-2.75	3.22	-4.66	-2.75	2.41	-4.66	
-2.75	2.41	-5.32	-2.75	2.33	-5.98	
-2.75	1.98	-6.56	-2.75	1.39	-6.62	
-2.75	0.0	-6.60				
-0.45	0.0	0.54	-0.45	1.01	0.47	
-0.45	1.90	0.04	-0.45	1.90	0.04	
-0.45	2.83	0.04	-0.45	3.80	0.04	
-0.45	3.80	0.04	-0.45	4.38	0.27	
-0.45	5.74	0.27	-0.45	6.91	-0.43	
-0.45	7.43	-1.71	-0.45	7.49	-3.16	
-0.45	6.91	-4.31	-0.45	5.74	-5.08	
-0.45	4.38	-5.68	-0.45	4.38	-5.08	
-0.45	3.41	-5.06	-0.45	2.52	-5.08	
-0.45	2.52	-5.68	-0.45	2.44	-6.01	
-0.45	2.17	-6.56	-0.45	1.39	-6.60	
-0.45	0.0	-6.60				
-0.45	0.0	0.54	-0.45	1.01	0.47	FUS NAC 9 PR
-0.45	1.90	0.04	-0.45	2.83	0.04	
-0.45	3.80	0.04	-0.45	4.38	0.27	
-0.45	5.74	0.27	-0.45	6.91	-0.43	
-0.45	7.49	-1.71	-0.45	7.49	-3.16	
-0.45	6.91	-4.31	-0.45	5.74	-5.08	
-0.45	4.38	-5.68	-0.45	3.41	-5.08	
-0.45	2.52	-5.68	-0.45	2.44	-6.01	
-0.45	2.17	-6.56	-0.45	1.09	-6.60	
-0.45	0.0	-6.60				
1.10	0.0	0.54	1.10	1.01	0.4603	
1.1	1.90	0.39	1.1	2.63	0.39	
1.1	3.648	0.39	1.1	4.42	0.47	
1.10	5.74	0.39	1.10	6.63	-0.31	
1.10	7.33	-1.55	1.10	7.33	-2.67	
1.10	6.83	-4.11	1.10	5.74	-4.89	
1.10	4.42	-5.61	1.10	3.41	-5.81	
1.10	2.52	-5.01	1.10	2.44	-6.01	
1.10	2.17	-6.56	1.10	1.09	-6.60	
1.10	0.0	-6.60				

ORIGINAL PAGE IS OF POOR QUALITY

1.10	1.36	0.35	1.10	[illegible]	1.29	FAIRING	
1.10	5.640	0.51	1.10	5.415	0.30		
2.01	1.90	0.44	2.01	3.648	0.44		
2.01	5.640	0.51	2.01	6.415	0.360		
3.01	1.90	0.49	3.01	3.648	0.49		
3.01	5.640	0.51	3.01	6.415	0.401		
4.009	1.900	0.511	4.143	3.640	0.488		
4.256	5.640	0.469	4.356	6.415	0.451		
1.10	6.415	0.0	1.10	6.98	-0.54	NAC SIDE	PR
1.10	7.33	-1.55	1.10	7.33	-2.87		
1.10	5.63	-4.11	1.10	5.74	-4.89		
3.31	6.255	-3.416	3.31	6.255	-6.416		
2.60	7.15	-1.46	2.35	7.19	-2.65		
1.69	6.74	-3.87	1.10	5.75	-4.89		
1.10	0.0	0.54	1.10	1.01	0.4603	FUS TOP	
1.10	1.90	0.39					
3.40	0.0	0.54	3.40	0.95	0.525		
3.40	1.90	0.51					
6.65	0.0	0.54	6.65	0.95	0.47		
6.65	1.90	0.39					
10.55	0.0	0.53	10.55	1.01	0.43		
10.55	1.90	0.0					
1.10	2.154	-0.247	1.10	2.52	-1.24	FUS BOT	PR
1.10	2.52	-2.56	1.10	2.52	-3.38		
1.10	2.52	-5.01	1.10	2.44	-6.01		
1.10	2.17	-6.56	1.10	1.39	-6.60		
1.10	0.0	-6.60					
3.40	2.275	-0.496	3.40	2.52	-1.67		
3.40	2.52	-2.83	3.40	2.52	-4.00		
3.40	2.52	-5.08	3.40	2.44	-6.01		
3.40	2.17	-6.56	3.40	1.39	-6.60		
3.40	0.0	-6.60					
6.65	2.190	-0.387	6.65	2.48	-1.59		
6.65	2.48	-2.75	6.65	2.48	-3.96		
6.65	2.46	-4.97	6.65	2.37	-5.78		
6.65	2.02	-6.32	6.65	1.25	-6.48		
6.65	0.0	-6.48					
10.55	1.93	0.0	10.55	2.37	-1.01		
10.55	2.48	-2.10	10.55	2.48	-3.22		
10.55	2.41	-4.31	10.55	2.21	-5.35		
10.55	1.75	-5.94	10.55	1.05	-6.13		
10.55	0.0	-6.13					
10.55	0.0	0.50	10.55	1.01	0.43	FUS AFT	
10.55	1.90	0.0	10.55	2.37	-1.01		
10.55	2.48	-2.10	10.55	2.48	-3.22		
10.55	2.41	-4.31	10.55	2.21	-5.35		
10.55	1.75	-5.94	10.55	1.05	-6.13		
10.55	0.0	-6.13					
16.40	0.0	0.43	16.40	0.89	0.35		
16.40	1.71	0.0	16.40	2.25	-0.70		
16.40	2.41	-1.55	16.40	2.41	-2.44		
16.40	2.33	-3.30	16.40	2.10	-4.15		
16.40	1.63	-4.85	16.40	0.81	-5.24		
16.40	0.0	-5.32					
24.10	0.0	0.23	24.10	0.58	0.12		
24.10	1.13	-0.16	24.10	1.59	-0.62		
24.10	1.50	-1.16	24.10	1.98	-1.78		
24.10	1.90	-2.41	24.10	1.59	-2.95		
24.10	1.13	-3.41	24.10	0.58	-3.69		
24.10	0.0	-3.80					
31.00	0.0	0.23	31.0	0.59	0.12		
31.00	1.13	-0.16	31.0	1.59	-0.62		
31.00	1.90	-1.16	31.0	1.98	-1.78		
31.00	1.90	-2.41	31.0	1.59	-2.95		
31.00	1.13	-3.41	31.0	0.58	-3.69		
31.00	0.0	-3.80					

ORIGINAL PAGE IS
OF POOR QUALITY

3.1475	3.14	-2.572	3.1475	4.09	-2.572	[illegible]	[illegible]
3.3275	5.64	-2.39	3.1475	5.99	-2.572	FWD NOZZLE	00
2.656	6.665	-3.364	1.984	6.94	-3.736		
1.312	6.665	-4.468	0.6205	5.99	-4.9		
0.6405	5.04	-5.08	0.6205	4.09	-4.9		
0.8205	3.14	-4.9					
3.938	3.14	-3.755	3.938	4.09	-3.755		
4.173	5.64	-3.056	3.938	5.99	-3.755		
3.296	6.685	-4.02	2.418	6.94	-4.385		
1.54	6.665	-4.75	0.698	5.99	-5.015		
0.653	5.04	-5.112	0.698	4.09	-5.015		
0.898	3.14	-5.125					
4.215	3.14	-5.15	4.215	4.09	-5.15		
4.47	5.64	-5.15	4.215	5.99	-5.15		
3.52	6.685	-5.15	2.57	6.94	-5.15		
1.62	6.665	-5.15	0.925	5.99	-5.15		
0.67	5.04	-5.15	0.925	4.09	-5.15		
0.925	3.14	-5.15					
6.84600	20.12500	-.00113	6.52330	20.12500	-.03383	WING	PR
8.09420	20.12500	-.07679	7.44980	20.12500	-.14231		
6.80540	20.12500	-.20436	6.05360	20.12500	-.25346		
5.40920	20.12500	-.26853	4.76460	20.12500	-.25024		
4.33520	20.12500	-.21856	4.01300	20.12500	-.17928		
3.79620	20.12500	-.14123	3.63710	20.12500	-.10203		
3.52970	20.12500	-.06069	3.47630	20.12500	0.00000		
3.52970	20.12500	.06068	3.63710	20.12500	.10203		
3.79626	20.12500	.14123	4.01300	20.12500	.17928		
4.33520	20.12500	.21856	4.70480	20.12500	.25024		
5.40920	20.12500	.26853	6.05360	20.12500	.25346		
6.80540	20.12500	.20435	7.44980	20.12500	.14231		
8.09420	20.12500	.07679	8.52300	20.12500	.03383		
8.84600	20.12500	.00113	9.11450	20.12500	0.00000		
9.36330	20.12500	0.00000	9.63150	20.12500	0.00000		
9.09400	17.48400	-.00123	8.72956	17.48400	-.03827		
8.24364	17.48400	-.08685	7.51476	17.48400	-.16096		
6.78568	17.48400	-.22381	5.93552	17.48400	-.28669		
5.20664	17.48400	-.36370	4.47776	17.48400	-.28335		
3.99184	17.48400	-.24721	3.62740	17.48400	-.20166		
3.38644	17.48400	-.15975	3.26222	17.48400	-.11541		
3.08074	17.48400	-.06864	3.02806	17.48400	0.00000		
3.08074	17.48400	.06864	3.26222	17.48400	.11541		
3.38644	17.48400	.15975	3.62740	17.48400	.20166		
3.99184	17.48400	.24721	4.47776	17.48400	.28335		
5.20664	17.48400	.30370	5.93552	17.48400	.28669		
6.78588	17.48400	.22081	7.51476	17.48400	.16096		
8.24364	17.48400	.08686	6.72956	17.48400	.03827		
9.09400	17.48400	.00128	9.39770	17.48400	0.00000		
9.71140	17.48400	0.00000	10.02510	17.48400	0.00000		
9.35300	14.71600	-.00143	8.94434	14.71600	-.04291		
8.39946	14.71600	-.09743	7.50214	14.71600	-.18049		
6.76462	14.71600	-.25882	5.81128	14.71600	-.32148		
4.99296	14.71600	-.34055	4.17664	14.71600	-.31739		
3.63176	14.71600	-.27721	3.22310	14.71600	-.22613		
2.95666	14.71600	-.17913	2.74633	14.71600	-.12941		
2.61011	14.71600	-.07696	2.54200	14.71600	0.00000		
2.61011	14.71600	.07696	2.74633	14.71600	.12941		
2.95666	14.71600	.17913	3.22310	14.71600	.22613		
3.63176	14.71600	.27721	4.17664	14.71600	.31739		
4.99396	14.71600	.34055	5.81120	14.71600	.32148		
6.76482	14.71600	.25882	7.50214	14.71600	.18049		
8.39946	14.71600	.09746	8.94434	14.71600	.04291		
9.35300	14.71600	.00143	9.69355	14.71600	0.00000		
10.03410	14.71600	0.00000	10.37465	14.71600	0.00000		

ORIGINAL PAGE IS
OF POOR QUALITY

9.64216	11.94900	-.00159	9.15912	11.94900	-.04755
8.55529	11.94900	-.10794	7.04952	11.94900	-.20032
6.74376	11.94900	-.26632	5.36714	11.94900	-.35627
4.78126	11.94900	-.30723	3.67552	11.94900	-.35174
3.27166	11.94900	-.30723	2.91836	11.94900	-.25059
2.51686	11.94900	-.19851	2.27044	11.94900	-.14341
2.13946	11.94900	-.08529	2.26447	11.94900	0.00000
2.13946	11.94900	.08529	2.27044	11.94900	.14341
2.51686	11.94900	.19851	2.31802	11.94900	.25253
3.27166	11.94900	.30723	3.67552	11.94900	.35174
4.78128	11.94900	.37749	5.36714	11.94900	.35627
6.74376	11.94900	.26632	7.54952	11.94900	.20032
8.55526	11.94900	.10794	9.15912	11.94900	.04755
9.61250	11.94900	.00159	9.96940	11.94900	0.00000
10.36650	11.94900	0.00000	10.74420	11.94900	0.00000
9.87160	9.18200	-.00174	9.37390	9.18200	-.05220
8.71110	9.18200	-.11848	7.71690	9.18200	-.21955
6.72270	9.18200	-.31483	5.56280	9.18200	-.39105
4.56660	9.18200	-.41425	3.57440	9.18200	-.38608
2.91160	9.18200	-.33721	2.41456	9.18200	-.27506
2.08310	9.18200	-.21739	1.83455	9.18200	-.15742
1.66665	9.18200	-.09362	1.56600	9.18200	0.00000
1.66665	9.18200	.09362	1.83455	9.18200	.15742
2.08311	9.18200	.21731	2.41456	9.18200	.27506
2.91160	9.18200	.33720	3.57440	9.18200	.38608
4.56660	9.18200	.41425	5.56280	9.18200	.39105
6.72270	9.18200	.31483	7.71690	9.18200	.21955
8.71110	9.18200	.11848	9.37390	9.18200	.05220
9.87160	9.18200	.00174	10.28525	9.18200	0.00000
10.69950	9.18200	0.00000	11.11375	9.18200	0.00000
10.13000	6.41500	-.00189	9.58858	6.41500	-.05684
8.86692	6.41500	-.12931	7.76428	6.41500	-.23908
6.74164	6.41500	-.34284	5.43856	6.41500	-.42584
4.35592	6.41500	-.45110	3.27326	6.41500	-.42043
2.55152	6.41500	-.36720	2.01020	6.41500	-.29953
1.64932	6.41500	-.23729	1.37866	6.41500	-.17142
1.19622	6.41500	-.10195	1.10806	6.41500	0.00000
1.19622	6.41500	.10195	1.37866	6.41500	.17142
1.64932	6.41500	.23726	2.01020	6.41500	.29953
2.55152	6.41500	.36720	3.27328	6.41500	.42043
4.35592	6.41500	.45110	5.43856	6.41500	.42564
6.74164	6.41500	.34294	7.76428	6.41500	.23908
8.86692	6.41500	.12931	9.58868	6.41500	.05684
10.13600	6.41500	.00199	10.58110	6.41500	0.00000
11.03226	6.41500	0.00000	11.40334	6.41500	0.00000
10.25600	5.04000	-.00197	9.69472	5.04000	-.05914
8.94368	5.04000	-.13425	7.61712	5.04000	-.24878
6.69056	5.04000	-.35674	5.37624	5.04000	-.44311
4.24968	5.04000	-.46940	3.12312	5.04000	-.43748
2.37208	5.04000	-.38299	1.80680	5.04000	-.31168
1.43328	5.04000	-.24690	1.15164	5.04000	-.17837
.96388	5.04000	-.10698	.87000	5.04000	0.00000
.96388	5.04000	.10638	1.15164	5.04000	.17837
1.43328	5.04000	.24691	1.80680	5.04000	.31168
2.37208	5.04000	.38209	3.12312	5.04000	.43748
4.24968	5.04000	.46940	5.37624	5.04000	.44311
6.69156	5.04000	.35674	7.61712	5.04000	.24878
8.94366	5.04000	.13425	9.69472	5.04000	.05914
10.25600	5.04000	.00197	10.72740	5.04000	0.00000
11.19680	5.04000	0.00000	11.61620	5.04000	0.00000
10.30900	3.64800	-.00235	9.83346	3.64800	-.06148
9.02274	3.64800	-.13955	7.85166	3.64800	-.25861
6.68458	3.64800	-.37084	5.31432	3.64800	-.46362
4.14324	3.64800	-.48795	2.97216	3.64800	-.45477
2.19144	3.64800	-.39719	1.60590	3.64800	-.32400
1.21554	3.64800	-.25666	.92277	3.64800	-.18542
.72759	3.64800	-.11028	.63008	3.64800	0.00000
.72759	3.64800	.11029	.92277	3.64800	.18542
1.21554	3.64800	.25666	1.60590	3.64800	.32400

ORIGINAL PAGE IS
OF POOR QUALITY

2.15144	3.64400	.43719	2.97216	3.64400	.45377		
4.14324	3.64400	.48795	5.31452	3.64400	.46052		
6.64058	3.64400	.37064	7.35106	3.64400	.25861		
9.02274	3.64400	.13955	9.81546	3.64400	.05148		
10.35930	3.64400	.00205	10.87695	3.64400	0.00000		
11.35430	3.64400	0.00000	11.63265	3.64400	0.00000		
10.552	1.90	-.00215	9.9357	1.9435	-0.2043		
9.1149	2.0454	-0.1450	7.8190	2.0931	-0.2695		
6.6692	2.1339	-0.3856	5.2323	2.2622	-0.4763		
4.0378	2.2772	-0.5062	2.3222	2.2703	-0.4716		
2.0945	2.2456	-0.4124	1.3554	2.1957	-0.3368		
0.9806	2.1501	-0.2671	0.6073	2.08	-0.1932		
0.4551	2.0	-0.1151	0.32230	1.9000	0.0		
.43024	1.90000	.11553	.53472	1.90000	.19426		
.96144	1.90000	.26883	1.35040	1.90000	.33944		
1.96384	1.90000	.41612	2.73176	1.90000	.47644		
4.06064	1.90000	.51120	5.23552	1.90000	.46257		
6.66658	1.90000	.38851	7.69376	1.90000	.27094		
9.12064	1.90000	.14620	9.97856	1.90000	.06441		
10.55200	1.90000	.00215	11.06320	1.90000	0.00000		
11.57440	1.90000	0.00000	12.02560	1.90000	0.00000		
10.73600	0.00000	-.00225	10.06620	0.00000	-.06760		
9.22780	0.00000	-.15344	7.94020	0.00000	-.28435		
6.65260	0.00000	-.40774	5.15040	0.00000	-.50646		
3.66280	0.00000	-.53650	2.57520	0.00000	-.50062		
1.71660	0.00000	-.43671	1.07300	0.00000	-.35624		
.64360	0.00000	-.28221	.32190	0.00000	-.20387		
.10730	0.00000	-.12125	0.00000	0.00000	0.00000		
.10730	0.00000	.12125	.32190	0.00000	.20387		
.64360	0.00000	.28221	1.07300	0.00000	.35624		
1.71680	0.00000	.43671	2.57520	0.00000	.50902		
3.66280	0.00000	.53650	5.15040	0.00000	.50646		
6.65260	0.00000	.40774	7.94020	0.00000	.28435		
9.22780	0.00000	.15344	10.06620	0.00000	.06760		
10.73000	0.00000	.00225	11.26650	0.00000	0.00000		
11.80300	0.00000	0.00000	12.33950	0.00000	0.00000		
-5.85	3.45	-1.2	-5.85	3.2	-1.5	INLET	PR
-5.85	2.88	-2.35	-5.85	2.88	-3.15		
-5.85	3.23	-4.	-5.85	3.47	-4.3		
-5.85	3.75	-0.92	-5.85	3.75	-1.5		
-5.85	3.75	-2.35	-5.85	3.75	-3.15		
-5.85	3.75	-4.0	-5.85	3.75	-4.52		
-5.85	4.6	-0.58	-5.85	4.6	-1.5		
-5.85	4.6	-2.35	-5.85	4.6	-3.15		
-5.85	4.6	-4.0	-5.85	4.6	-4.85		
-5.85	5.4	-0.58	-5.85	5.4	-1.5		
-5.85	5.4	-2.35	-5.85	5.4	-3.15		
-5.85	5.4	-4.0	-5.85	5.4	-4.85		
-5.85	6.25	-0.92	-5.85	6.25	-1.5		
-5.85	6.25	-2.35	-5.85	6.25	-3.15		
-5.85	6.25	-4.0	-5.85	6.25	-4.52		
-5.85	6.55	-1.2	-5.85	6.8	-1.5		
-5.85	7.12	-2.35	-5.85	7.12	-3.15		
-5.85	6.77	-4.0	-5.85	6.53	-4.3		
3.0							
3.0							
3.0							
1.0							
1.0							
1.0							
0.0							
0.0							
0.0							
999.							
STOP							

5.0 References

4-1 Mineck, R.E.; and Schwendemann, M.F.; "Aerodynamic Characteristics of a Vectored-Thrust V/STOL Fighter in the *Transition Speed Range*." NASA Tnd-7191 (May 1973)

5-1 Stockman, N. D.; and Button, S. L.; "Computer Program For Calculating Potential Flow In Propulsion System Inlets," NASA TMX-68278, 1973

5-2 Ziegler, H; and Wooler, P. T.: "Analysis of Stratified and Closely Spaced Jets Exhaustiung Into a Crossflow," NASA CR-132297, 1973.

6.0 VAPE SUBROUTINES

The VAPE program system contains over 190 subroutines. These subroutines can be divided into seven primary areas as shown below:

- o VAPE Main System
- o Hess Lifting Program
- o Viscous Module
- o Inlet Analysis
- o Vought/Weston Jet Model
- o Wooler Jet Model
- o Thames Rectangular Jet Model

The subroutines assigned to the VAPE main system are general routines, i.e., read and write routines which are used throughout the VAPE system. In Section 6.1, a complete listing of all subroutines, the main area the routine is associated with, and a short explanation of the purpose of the subroutine is supplied. In Section 6.2, a series of flow charts are given showing the relationship of the various subroutines.

6.1 SUBROUTINE DESCRIPTION

All of the subroutines contained in the VAPE system are listed on the following pages in alphabetical order. The main system component that the routine is associated with is given along with a short explanation of the subroutine.

SUBROUTINE	MAIN SYSTEM COMPONENT	DESCRIPTION
ADAMS	Wooler Jet Model	Solves a system of N order differential equations by means of a fourth order ADAMS predictor/corrector method.
AFORM	Hess Lifting Program	Performs the DOT product of the source velocities and/or onset velocities at each control point with the normal vector at that point forms the A(I, J) matrix.
AREAA	Inlet Analysis	Calculates the circular area between SHROUD and HUB.
AVEV	Inlet Analysis	Primary calculation routine in subroutine COMBYN. Calculates areas and velocities.
AXISA	Inlet Analysis	Compute axisymmetric velocity components VX, VY, VT, CP.
BALANC	Wooler Jet Method	Establishes initial conditions for merged jet from momentum balance of 2 merging jets.

SUBROUTINE	MAIN SYSTEM COMPONENT	DESCRIPTION
BALNCW	Vought/Weston Jet Method	Establishes initial conditions for merged jet from momentum balance of 2 merging jets.
BASIC 1	Inlet Analysis	Reads in input data and does initial program calculations for uniform flow.
BASIC 2	Inlet Analysis	Read in input data and es initial program calculations for non-uniform flow.
BITEST	Wooler Jet Model	Tests for blockage of 2nd jet by 1st jet and checks for inter section of the two jets.
BOUNDL	Viscous Module	Main program for Cebeci-Smith boundary layer code used in viscous solution.
BSETUP	Viscous Module	Reads in boundary layer input data and transforms Hess output data to boundary layer input requirements for Cebeci-Sm th code.
BUFSHR	VAPE	System routine to allow buffer sharing.
CALCRS	Viscous Module	Computes elements of a new right hand side for Hess from the boundary layer displacements and velocities.
CALVEL	Vought/Westor Jet Model	Calls routines to calculate induced velocities.
CDELTA	Vought/Wescon Jet Model	Calculates trigonometric values of jet injection angle.
CFCAL	Wooler Jet Model	Computes direction cosines of local jet coordinate system.
CFCAL 1	Wooler Jet Model	Computes directional cosines at local jet coordinate system.
COLSOL	Hess Lifting Program	Matrix solution routine.
COMBYN	Inlet Analysis	Main control routine to calculate velocities for inlet analysis routine with viscous effects.
COMFLOW	Hess Lifting Program	Routine to control velocity solution after matrix is solved.

SUBROUTINE	MAIN SYSTEM COMPONENT	DESCRIPTION
COMP	Wooler Jet Model	Computes V/V effective and tests for intersection of centerlines.
CONST	Inlet Analysis	Calculates constants used in subroutine COMBYN
COTR	Inlet Analysis	Reads in all input data for viscous routine.
CROSS	Inlet Analysis	Computes cross flow velocity components.
CRPROD	Vought/Weston and Rectangular Jet Method	Calculates cross product of two vectors.
CUBIC	Inlet Analysis	Fits a cubic between 2 straight lines.
CORVFM	Weston Jet Model	Forms jet or vortex curves.
DBCQDU	Inlet Analysis	Computes the double integral of a table using splines.
DBCQDU	Wooler Jet Method	Integration of F(X) from A to B using cautious adaptive romberg extrapolation.
DCOSJ	Weston Jet Model and Rectangular Jet Model	Computes direction cosines of local coordinate system.
DCOSJI	Rectangular Jet Model	Computes direction cosines of jet deflection (routine identical to DCOSJ).
DCSQDU	Inlet Analysis	Integrates a cubic spline between A and B.
DERIV	Wooler Jet Model	Computes derivatives for ADAMS predictor 1 corrector method.
DIRCOS	Vought/Weston Jet Model	Computes direction cosines between 2 points.
EDVS	Viscous Module	Calculates eddy viscosity for CEBECI-SMITH boundary layer method.
EINF	Viscous Module	Calculates transformed Y-grid points for Cebeci-Smith boundary layer method.
ELIP	Inlet Analysis	Hastings approximation for elliptic integrals.

SUBROUTINE	MAIN SYSTEM COMPONENT	DESCRIPTION
ENGY	Viscous Module	Calculates solution to energy equation for Cebeci-Smith boundary layer method.
EOD	Inlet Analysis	Hess axisymmetric potential flow main control program.
ERF	Weston Jet Model	Error function calculation routine.
EXCRCS	Inlet Analysis	Compute extra cross flow velocities for axisymmetric potential flow.
FILE	Inlet Analysis	Lists the momentum and energy profiles on Y and the wall station parameters at specified X stations.
FINDYS	Inlet Analysis	Finds value of Y for hub and shroud at rake location - (Determines min. and max. height at rake).
FIX	Wooler Jet Model	Limits mutually induced velocities to a maximum valve.
FLP2	Viscous Module	Determines fluid properties for Cebeci-Smith boundary layer code.
FMCAR	Inlet Analysis	Control program for force and moment calculations.
FMCMOM	Inlet Analysis	Compute moment force on internal surface.
FMDATN	Inlet Analysis	Reads data and initializes calculation.
FMFLUX	Inlet Analysis	Computes momentum flux.
FMINP	Inlet Analysis	Reads data for force and moment calculations.
FMINT	Inlet Analysis	Compute inside P-A integral in X direction.
FMOUT	Inlet Analysis	Output routine for force and moment calculations.
FNSTRH	Inlet Analysis	Find straight segment on hub and shroud.
FONISO	Inlet Analysis	Find N for the supercircle $F(N) = (X/a)^n + (Y/B)^n - 1$

SUBROUTINE	MAIN SYSTEM COMPONENT	DESCRIPTION
FCRMOM	Inlet Analysis	Main control program for force and moment calculation.
FRSTSH	Inlet Analysis	Find first straight segment on shroud.
GEOMOD	Inlet Analysis	Modifies inlet geometry to account for boundary layer displacement thickness.
GETABC	Inlet Analysis	Computes V1, V2, V3 and A, B, C from input parameters.
GETMT	Inlet Analysis	Opens files.
GROUNDH	Inlet Analysis	Calculates ground height.
HEADK	Viscous Module	Prints header on each page of Cebeci-Smith boundary layer output.
HESS	Hess Lifting Program	Main control program for Hess.
HINIT	Hess Lifting Program	Reads all input data for Hess, including jet data. Lists it out and transfers it to Unit 14.
ICSEVU	Inlet Analysis	Evaluation of a cubic spline.
ICSICU	Inlet Analysis	Interpolatory approximation by cubic splines with arbitrary second derivative end conditions.
ICSSU	Inlet Analysis	Cubic spline data smoothing.
INBLOCK	Weston Jet Model	Determination of equivalent velocity due to jet blockage at 2nd jet exit.
INCRMT	Rectangular Jet Model	Calculates increment length for jet curves.
INDEX	Inlet Analysis	A functional subroutine which compares or tabular function X with a functional Z to find the index of X such that X is the least tabular value of X greater than Z.
INIR	Inlet Analysis	Determines initial conditions for boundary layer calculations.
INITMT	VAPE	Initial routine in VAPE - sets program control parameters

SUBROUTINE	MAIN SYSTEM COMPONENT	DESCRIPTION
INLINT	Hess Lifting Program	Finds inlet CP's by interpolation.
INPUT	Hess Lifting Program	Reads data from Unit 14 for Hess 3-D potential flow routine.
INPUTW	Vought/Weston Jet Model	Reads input data for Weston routine. Also determines jet spacing in terms of jet diameters.
INP2	Viscous Module	Processes all input to the Cebeci-Smith boundary layer code.
INS2	Viscous Module	Linear or quadratic interpolation routine.
INTEG	Inlet Analysis	Integrates sum by trapezoidal rule.
INTEGA	Wooler Jet Model	Integration of the equations of motion for the jet path.
INTPOL	Inlet Analysis	Interpolation and differentiation.
INTSEC	Vought/Weston Jet Model	Determines if merging of jets occurs and what direction cosines of jets 1 and 2 are at merging point.
ITFR	Inlet Analysis	Generates new initial FP and GP profiles for viscous solution.
ITSR	Inlet Analysis	Main subroutine for computation of momentum and energy profiles.
ITS2	Viscous Module	Integration routine in Cebeci-Smith boundary layer code.
IVPF	Viscous Module	Generates initial velocity profile for Cebeci-Smith boundary layer solution.
JDRCOS	Vought/Weston Jet Model	Calculates direction cosines of freestream and jets.
JETCET	Vought/Weston Jet Model	Calculates jet centerline location.
JETCT2	Vought/Weston Jet Model	Jet centerline location for wake effects.
JETOLD	Wooler Jet Model	This routine reads jet induced velocities computed in an earlier run.
JET 3	Wooler Jet Model	Main program for Wooler jet code.

SUBROUTINE	MAIN SYSTEM COMPONENT	DESCRIPTION
JET3IN	Wooler Jet Model	Input routine and parameter initilization for Wooler jet code.
JET3IT	Wooler Jet Model	Does initial calculations, including jet blockage and intersectional.
JET3ZZ	Wooler Jet Model	Calculates jet induced velocities.
LEM	Inlet Analysis	Calculates points on a lemiscate.
LIFT	Hess Lifting Program	Calculates geometric quantities for elements in the lifting section.
LINTP3	Rectangular Jet Model	Lineary interpolation of 3 independent variables.
LSEP	Viscous Module	Determines when a laminar separation point, as predicted, will be a transition location or an actual separation point.
LSTINP	VAPE	Lists all input cards.
MATRIX	Inlet Analysis	Computes matrix for potential flow solution.
MATSOL	Hess Lifting Program	Controls matrix solution routine (1) Colsol-Basic matrix solution, (2) Solmor-Solve for additional right hand sides with same matrix.
MERJET	Vought/Weston Jet Model	Determines jet centerline of merged jets.
MIRROR	Inlet Analysis	Mirrors the hub to obtain points on shroud (2-D inlets)
MISNA2	Inlet Analysis	Matrix solution-Siedel integra tion method.
MISI	Inlet Analysis	Matrix solution-direct inverse method.
MODIFY	Wooler Jet Model	Computes mutually induced velocities between jets.
MOMX	Viscous Module	Finds solution of X-momentum equation in Cebeci-Smith boundary layer code.
MOMZ	Viscous Module	Finds solution of Z-momentum equation in Cebeci-Smith boundary layer code.

SUBROUTINE	MAIN SYSTEM COMPONENT	DESCRIPTION
MUINT	Wooler Jet Model	Computes direction cosines of modified freestream and modified freestream to freestream velocity ratio.
NDIR	Inlet Analysis	Print boundary layer results summarized.
NEAR	Hess Lifting Program	Calculates source and dipole velocities of a lifting element in the near field-influence velocities for elements.
NOEPTS	Inlet Analysis	Determines end points of rakes near hubs shroud and/or splitters.
NOLIFT	Hess Lifting Program	Computes geometric quantities of the now lifting elements.
OFFBDY	Inlet Analysis	Calculates off-body variables.
OLCMFLO	Hess Lifting Program	Combines flow solutions and determines final velocities and pressures.
ONBODY	Inlet Analysis	Calculates on-body variables.
OTPT	Viscous Module	Outputs the results of the Cebeci-Smith boundary layer code.
OUTPT	Wooler Jet Model	Transforms local coordinates to program coordinates.
OUTPTI	Wooler Jet Model	Transforms local coordinates to program coordinates for segmented jets.
PART 1	Inlet Analysis	Control for basic data and matrix formulation.
PART 2	Inlet Analysis	Computer source density sigma by siedel iteration.
PART 4	Inlet Analysis	Computes velocity components and print.
PKUTTA	Hess Lifting Program	Computes vortex strength by kurta condition.
PLANE	Wooler Jet Model	Computes intersection of plane with a line.
PRELPS	Inlet Analysis	Calculates geometric propertities in geometry portion of inlet analysis.

SUBROUTINE	MAIN SYSTEM COMPONENT	DESCRIPTION
PREP	Inlet Analysis	Set up tapes for MATSOL solution.
PRINT	Hess Lifting Program	Prints final output.
PROFYL	Inlet Analysis	Computes F(ETA) and G(ETA) in viscous program.
PRTOUT	Wooler Jet Model	Prints ut jet centerline data and induced velocities at all control points.
READS	Inlet Analysis	Reads all input.
READ 1	VAPE	Reads block data from a unit.
READ 3	VAPE	Reads multi block data from a unit.
READ 4	Inlet Analysis	Reads data for force and moment calculations.
RECJET	Rectangular Jet Model	Main program for rectangular jet method.
REGEN	Inlet Analysis	Transfers data from Unit MT20 to MT29; part of viscous inviscid interaction.
RETMT	VAPE in general	Tape manipulation.
ROTATE	Wooler Jet Model	Rotates fixed coordinates to rotated or rotated to fixed.
SCIRCL	Inlet Analysis	Main geometry routine for inlet analysis.
SDIST	Vought/Weston Jet Model Inlet Analysis	Calculates surface distances.
SEGMNT	Wooler Jet Model	Establishes initial conditions for new segment of jet, for continuation, or a jet and integrates jets.
SETMT	VAPE	Sets up tapes.
SHFT	Viscus Module	Provides initial guess for each station in Cebeci-Smith boundary layer code.
SIMQ	Inlet Analysis	Solves set of simultaneous linear equations.
SINK	Vought/Weston Jet Model	Calculates induced velocities to due sinks along jet centerline.

SUBROUTINE	MAIN SYSTEM COMPONENT	DESCRIPTION
SINTP	Inlet Analysis	Calculates geometric parameters used in combination routine.
SLN6	Viscous Module	Determines surface distance from X-Y input for Cebeci-Smith boundary layer code.
SLOPE	Viscous Module	Determines derivative DY/DX from X vs Y input in Cebeci-Smith boundary layer code.
SOLMOR	Hess Lifting Program	Matrix solution routine. Solves basic Hess matrix with additional right hand sides.
SOLVIT	Inlet Analysis	Matrix solution routine.
SPLIN5	Viscous Module	Interpolation by cubic spline.
SRTNE	Inlet Analysis	Calculates surface distance used in combination routine.
STRAIT	Inlet Analysis	Calculates straight line segments in SCIRCL
STRLINE	Inlet Analysis	Calculates straight line segment.
STRML	Inlet Analysis	This routine calculates streamlines used in combination routine.
SUPERC	Inlet Analysis	Geometry routine in SCIRCL routine.
SUPRD	Inlet Analysis	Determines geometry of noise suppression splitter plates.
TEST	Inlet Analysis	Geometry routine used in SCIRCL geometry routine.
TRANS	Inlet Analysis	Transition location prediction routine.
TRANSA	Wooler Jet Model	Coordinate transformation routine.
TRANSF	Vought/Weston Jet Model	Coordinate transformation routine.
TRANSG	Inlet Analysis	Sets up data for viscous solution.
TRANS3	Wooler Jet Model	Coordinate transformation routine.
TRICK	Inlet Analysis	Smoothing routine.
TRNSF1	Rectangular Jet Model	Coordinate transformation routine.

SUBROUTINE	MAIN SYSTEM COMPONENT	DESCRIPTION
TRN2	Viscous Module	Computes location of boundary layer transition for Cebeci-Smith code.
UERTST	Inlet Analysis	Message generation.
VAPE	VAPE	Main routine for VAPE program. Controls basic logic of program.
VAROFF	Inlet Analysis	Calculates fluid properties off the body.
VBARIT	Inlet Analysis	Solves VBAR combination iteratively. Used in combination routine.
VCOM	Hess Lifting Program	Velocities of configuration determined. Jet and inlet velocities determined through control of this routine.
VELOC	Wooler Jet Model	Determines jet induced velocities.
VEL 1	Wooler Jet Model	Computes effective velocity ratio for downstream jet at exit.
VFMLFT	Hess Lifting Program	Computes the induced velocities in a lifting strip.
VFMNLF	Hess Lifting Program	Computes the induced velocities in a non-lifting strip.
VFORM	Hess Lifting Program	Controls calculation of velocity on a body, plus forms v-matrix.
VIS	Inlet Analysis	Computes effective viscosity and conductivity.
VISCOS	Inlet Analysis	Main control program for viscous routines.
VORCUR	Vought/Weston Jet Model	Definition of vortex curves.
VORT	Vought/Weston Jet Model	Calculate induced velocities due to vorticies.
VORTVEL	Wooler Jet Model	Vortex induced velocities calculated.
WALJET	Vought/Weston Jet Method (STOL)	Calculates effect of wall-jet on ground plane.
WESTON	Vought/Weston Jet Method	Main control program for Weston jet method.

SUBROUTINE	MAIN SYSTEM COMPONENT	DESCRIPTION
WNEAR	Hess Lifting Program	Calculates dipole velocities of wake element in near field.
WPUNCH	Inlet Analysis	Calculates geometric data and places on Unit 1 (MT20).
WRITE 1	VAPE	Write block data.
WRITE 2	VAPE	Write block data.
WRITE 3	VAPE	Write block data.
WRITE 4	VAPE	Write block data.
WRTXY	VAPE	Write data on Unit 20.
XPROD	Wooler Jet Model	Computes cross product of two vectors.
XYZ	Inlet Analysis	Control for X, Y, Z matrices computation.
XYZ1	Inlet Analysis	Compute X, Y, Z matrices for JJ less than or equal .08.
XYZZ	Inlet Analysis	Compute X, Y, Z matrices using Simpson rule integration.

6.2 SUBROUTINE FLOW CHARTS

Flow charts of the VAPE code showing relationships between subroutines are presented in this section. Figure 6.1 shows the main flow of the VAPE system. Figure 6.2 shows the logic for rutine GEOMOD. Figure 6.3 shows the flow for the axisymmetric Hess program. The viscous logic flow is contained in Figure 6.4. The input geometry formulation for the inlet analysis is contained in Figure 6.5. The routine which combines the flow fields in the inlet analysis routine is presented in Figure 6.6. The Hess routines and various jet methods are presented in Figures 6.7 through 6.9. In these diagrams, the subroutines are called from the other routines as shown. For presentation purposes, some of the reads, writes, and tape manipulation routines have been shown in the same block

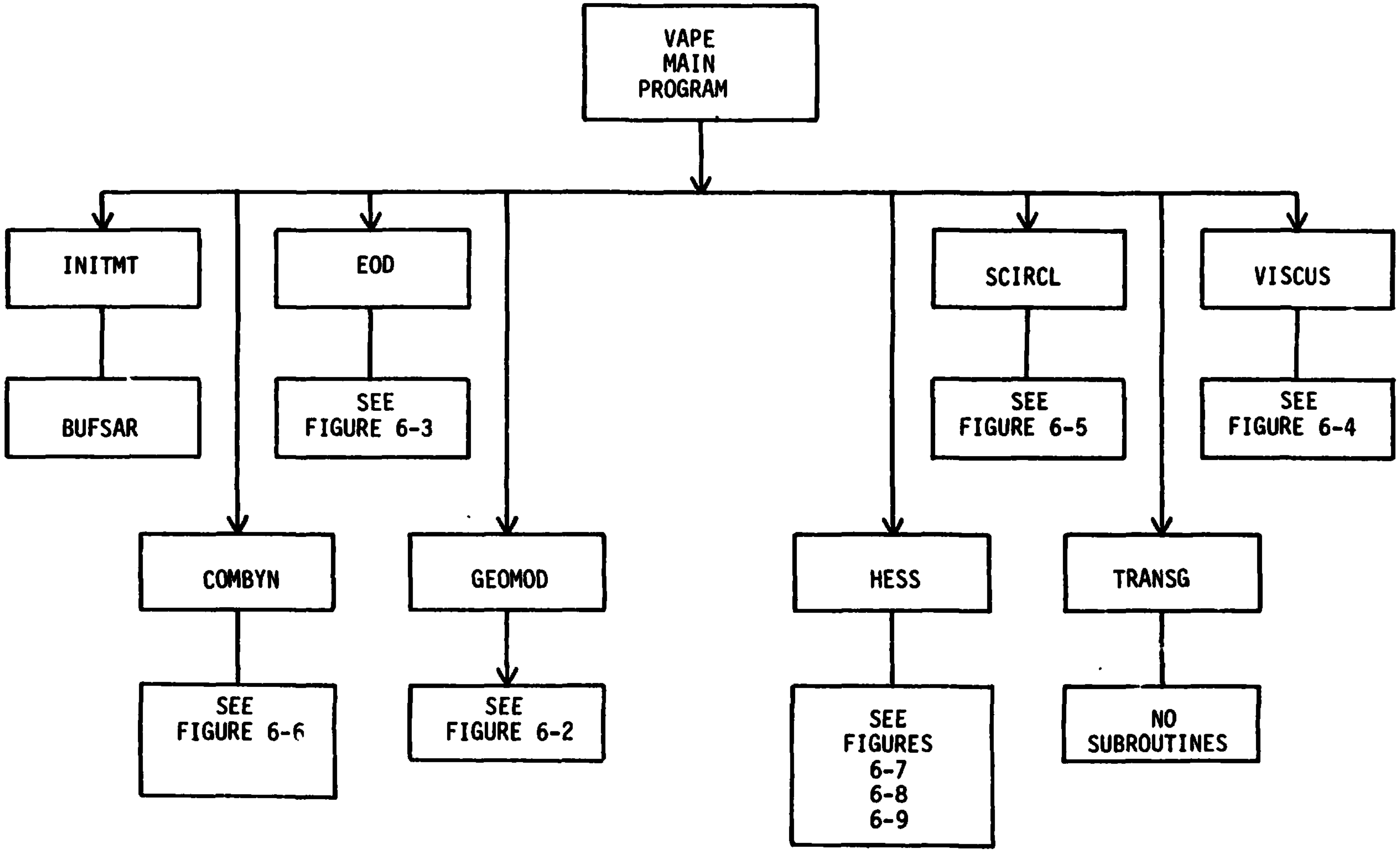


FIGURE 6-1. FLOW CHART OF VAPE SUBROUTINES

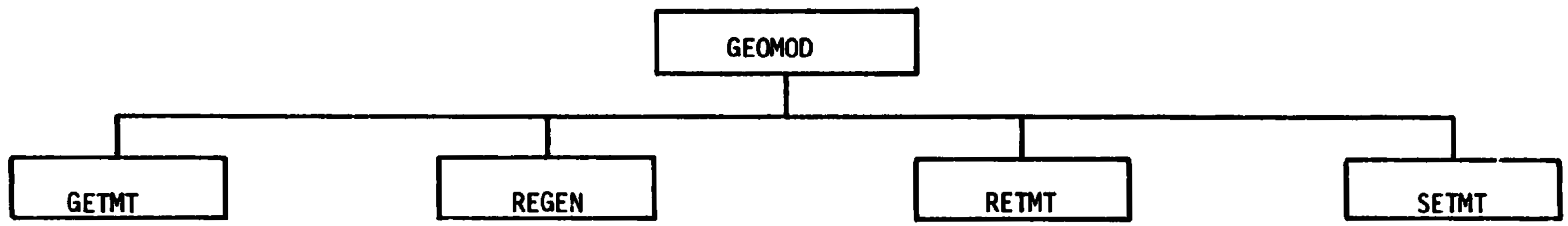


FIGURE 6-2. FLOW CHART OF GEOMOD SUBROUTINES

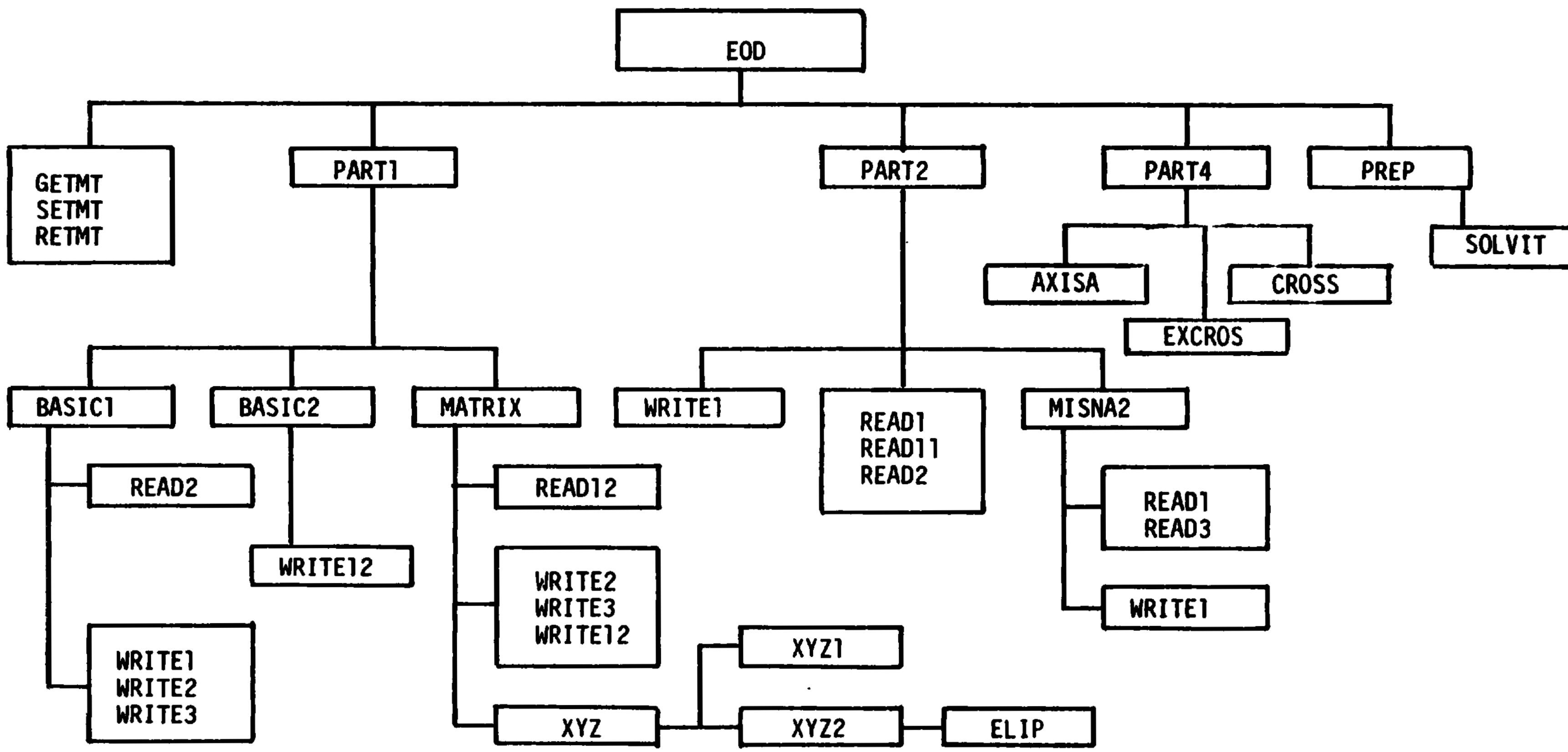


FIGURE 6-3. FLOW CHART OF EOD (AXISYMMETRIC HESS) SUBROUTINES

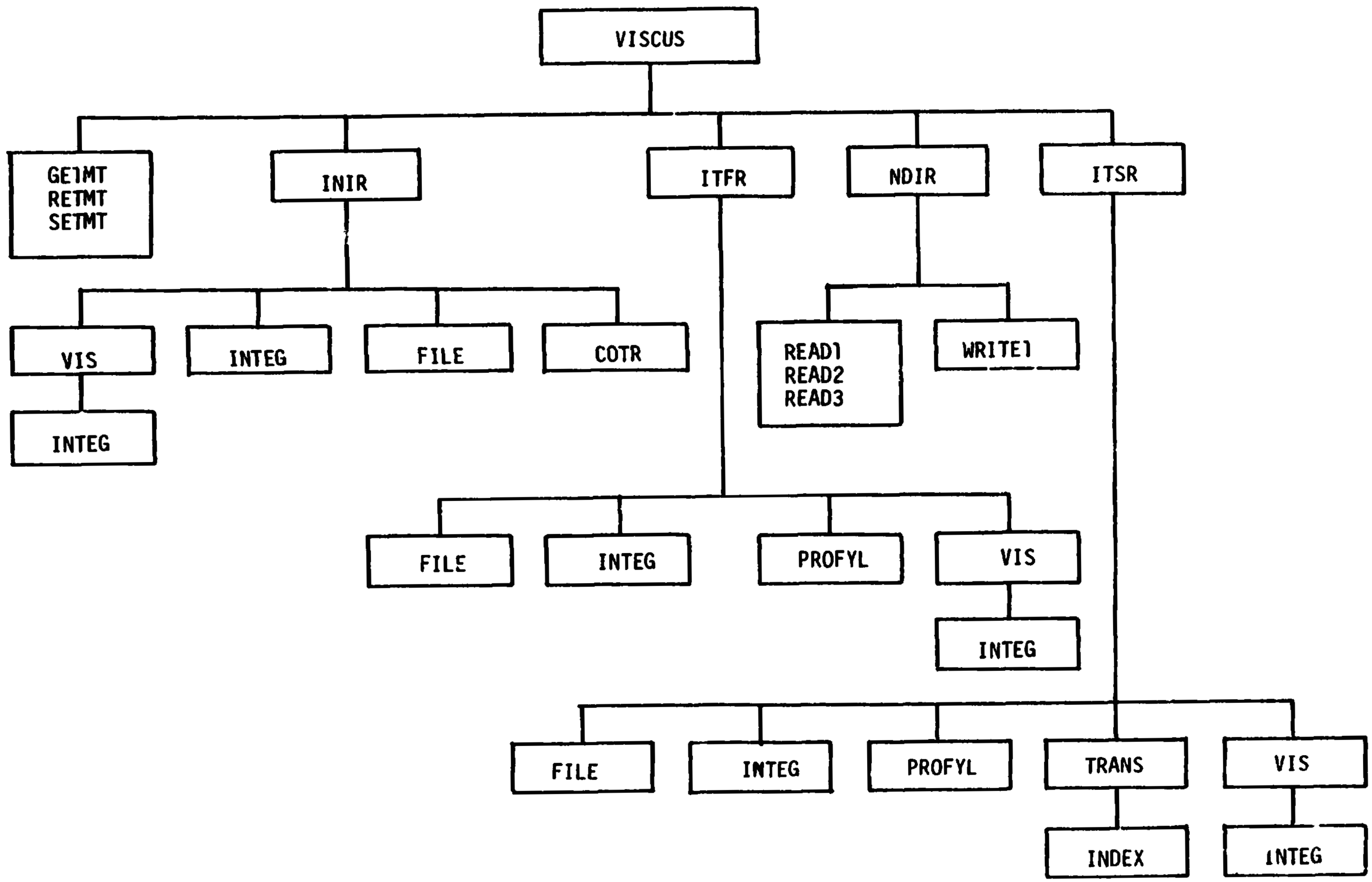


FIGURE 6-4. FLOW CHART OF VISCUS SUBROUTINES

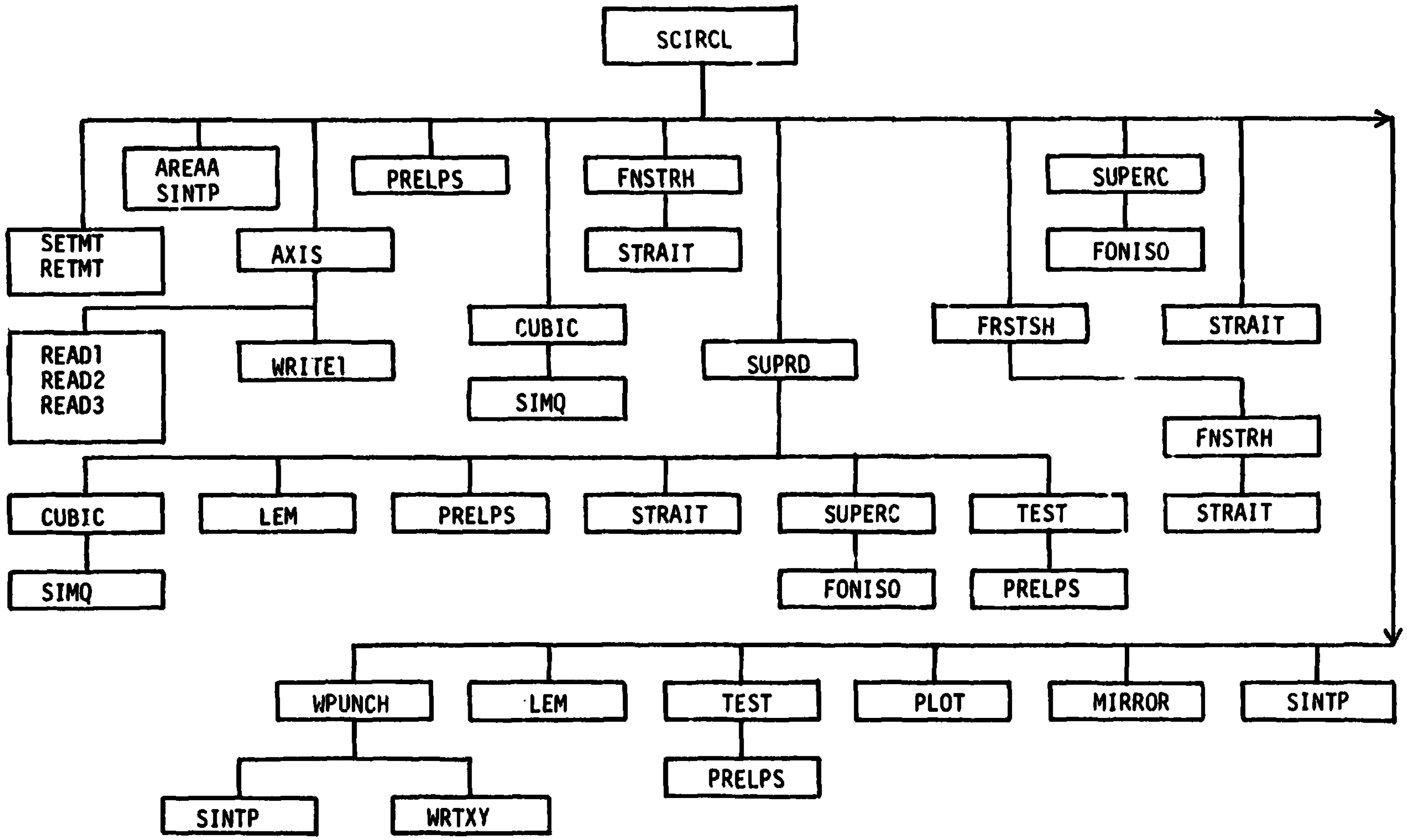


FIGURE 6-5. FLOW CHART OF SCIRCL SUBROUTINES

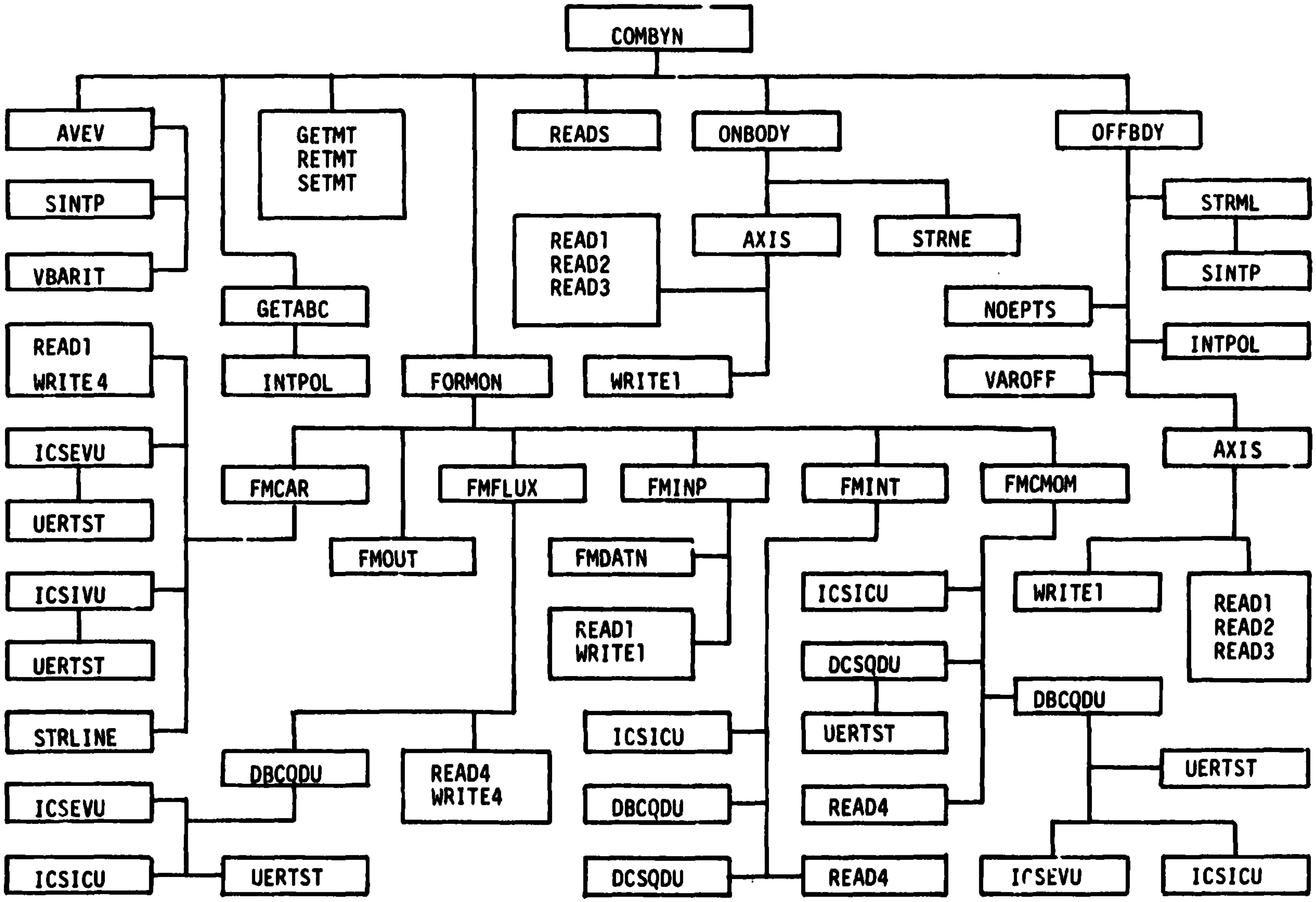


FIGURE 6-6. FLOW CHART OF COMBYN SUBROUTINES

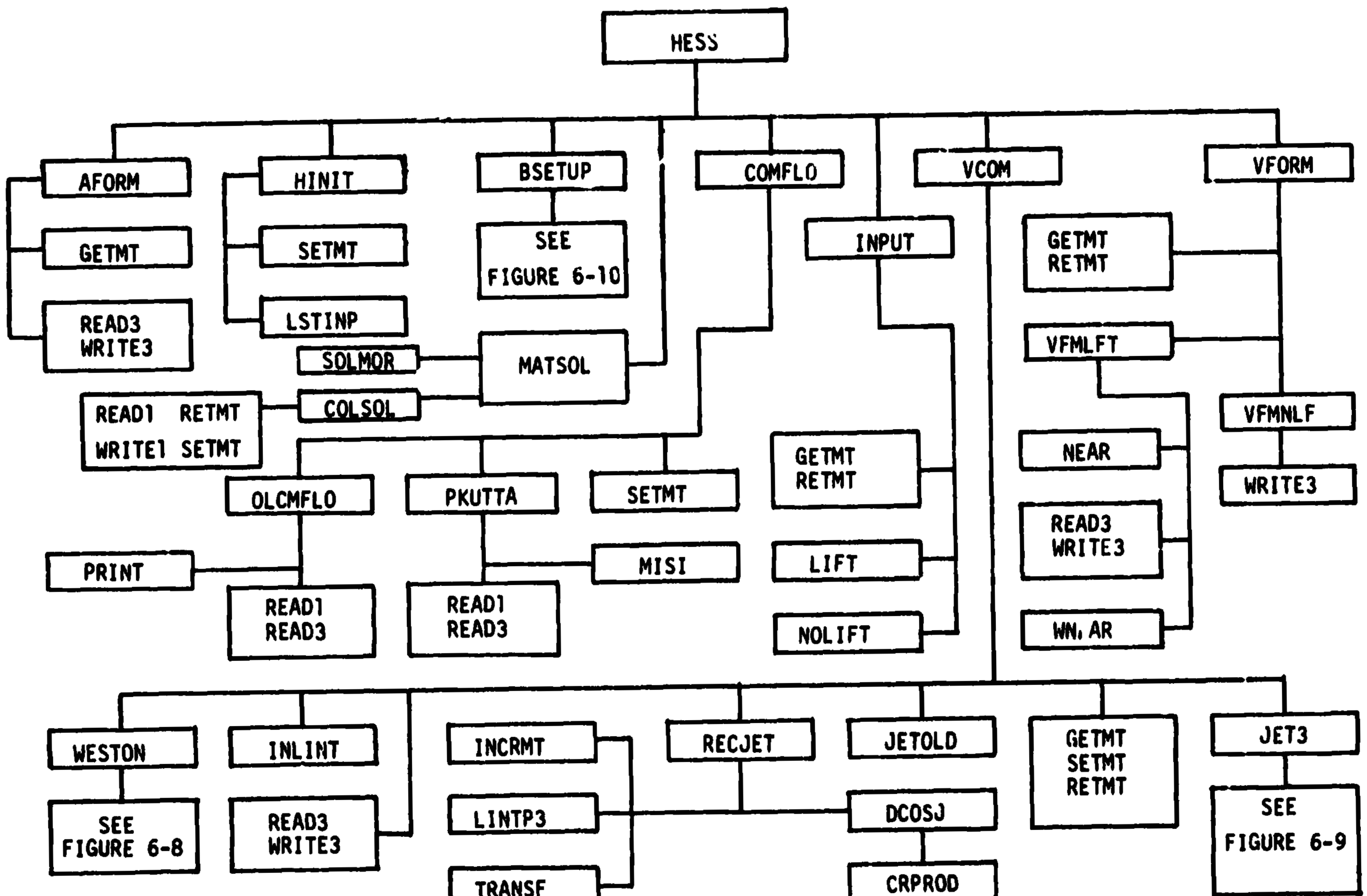


FIGURE 6-7. FLOW CHART OF HESS SUBROUTINES

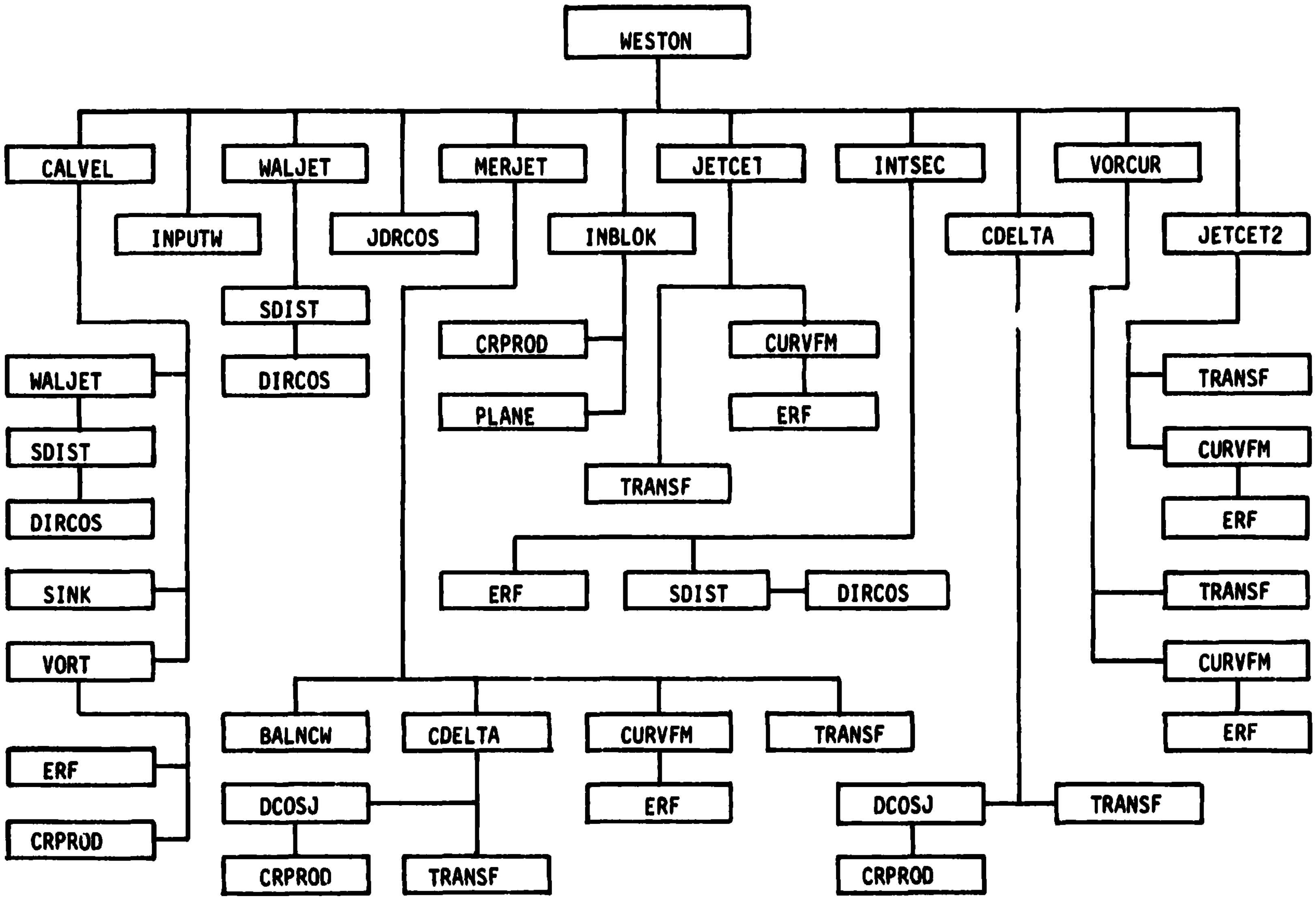


FIGURE 6-8. FLOW CHART OF WESTON SUBROUTINES

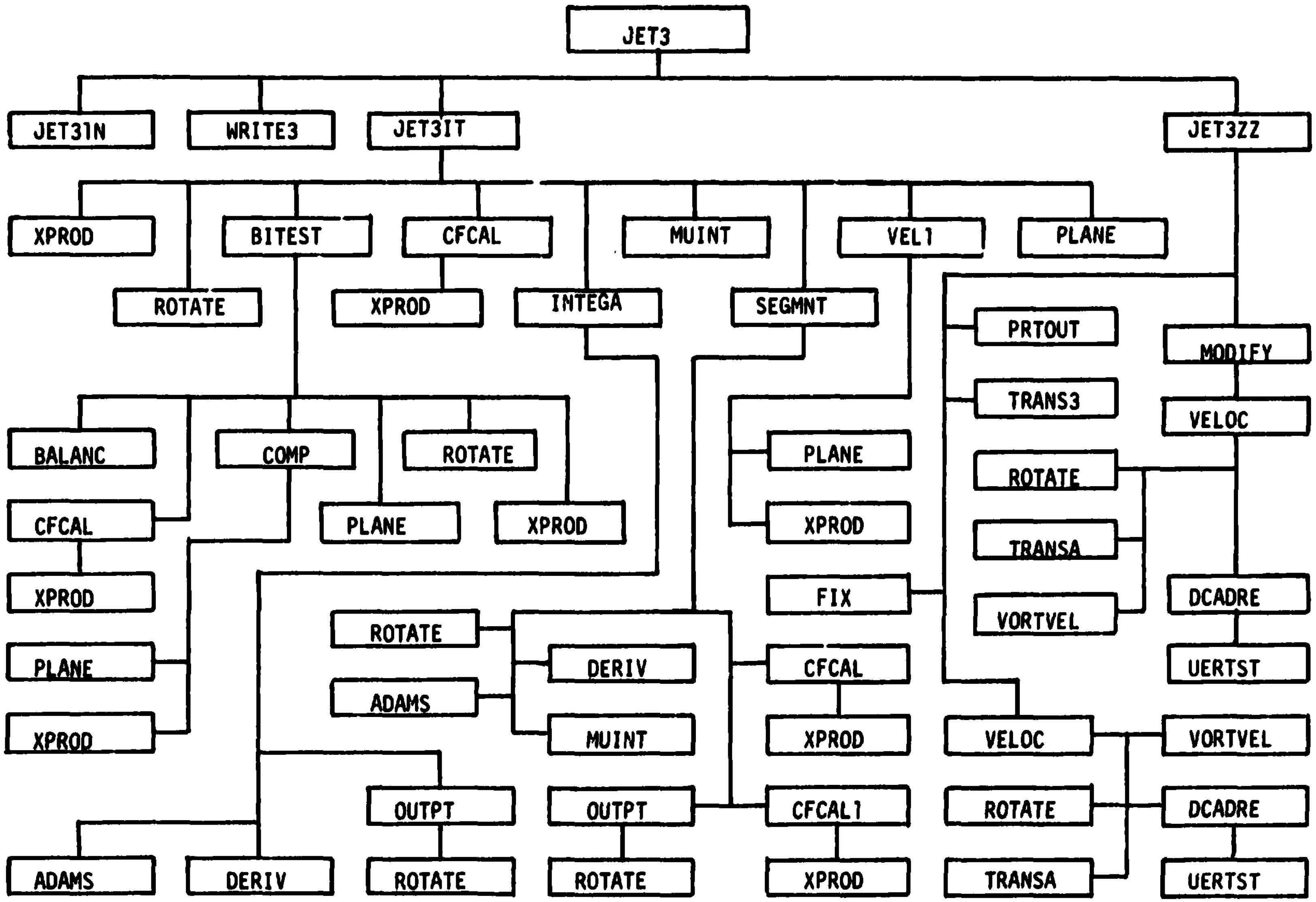


FIGURE 6-9. FLOW CHART OF JET3 (WOOLER) SUBROUTINES

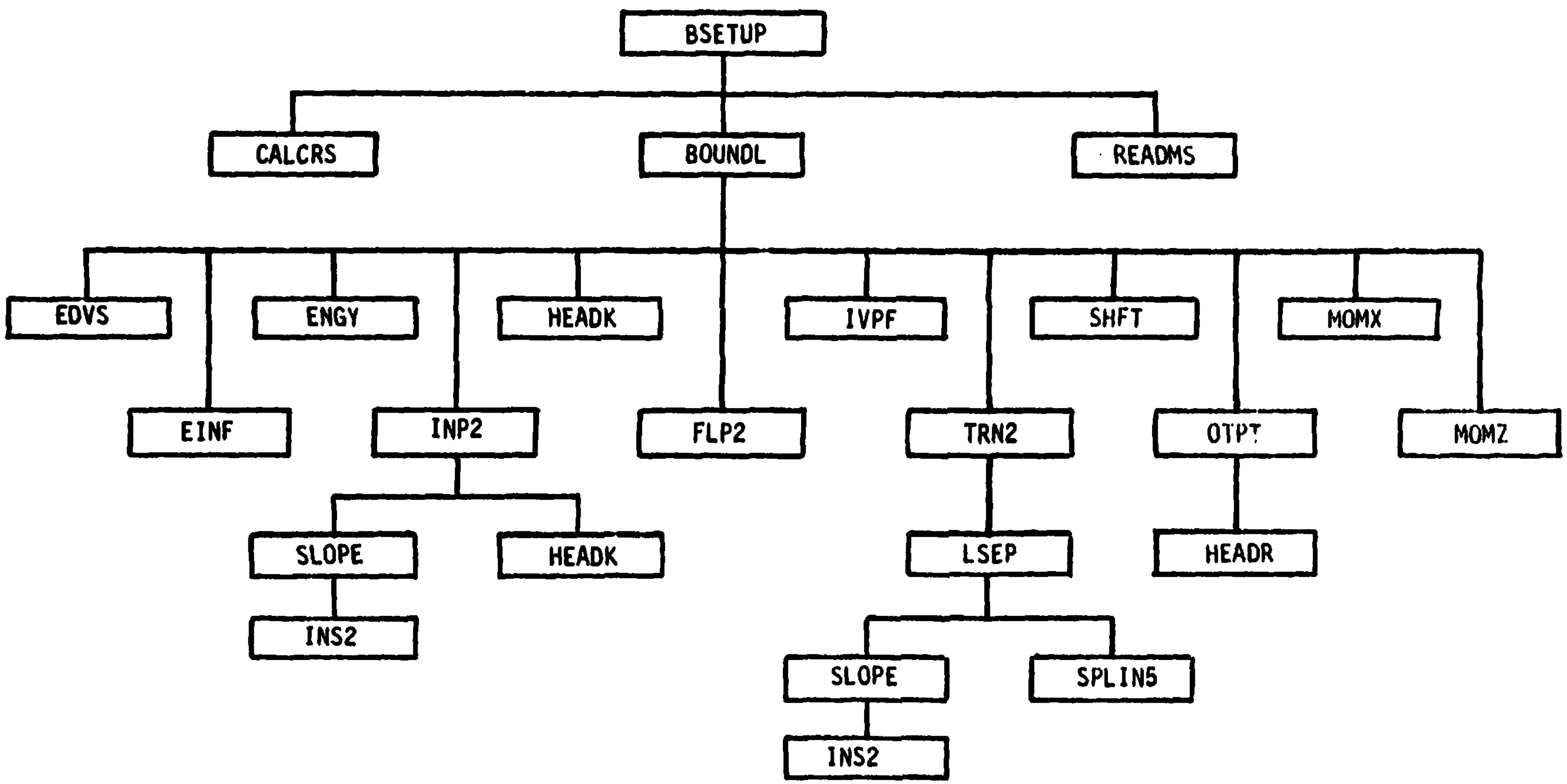


FIGURE 6-10. FLOW CHART OF VISCOUS MODULE

APPENDIX A - DESCRIPTION OF GEOMETRY PROGRAM FOR DEVELOPING HESS THREE-DIMENSIONAL INPUT

IN-1 PRIMARY CONTROL CARD (2A1, A8, 7A10)
This card controls the main flow of the program.

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	INST(1)	VINPEX A1	Selects module to be performed = F Wing module = J Junction module = C Conic or circle module depending on INST(2) = H Hesplot module - plots = S Stop
2	INST(2)	VINPEX A1	= O Conic routine = I Circle routine
3-80	INST(3)-INST(10)	VINPEX A8, 7A10	used to complete description of module desired not used in program except for output (i.e. foil, Juncpan, Hesplot, Stop, etc.).

INPUT TO WING GENERATION ROUTINE

This routine creates a wing panelled for direct input to the HESS program.

F-1 MAIN CONTROL CARD (16I5)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION	
1	NPTS	Foil I5	Number of coordinates on each surface of the airfoil	
6	NFOILI	Foil I5	= 0	NACA airfoil calculated for inboard profile shape
			≠ 0	Airfoil coordinates for inboard profile will be input.
11	NFOILO	Foil I5	= 0	NACA airfoil calculated for outboard profile shape
			≠ 0	Airfoil coordinates for out-board profile will be input.
16	IND	Foil I5	= 0	Divide wing into NS equal panels in spanwise direction
			≠ 0	Read in non-dimensional span-wise values (N = y/b/2)
21	NS	Foil I5	Number of spanwise airfoils to be used.	
26	IDIHED	Foil I5	= 0	No dihedral angle considered
			≠ 0	Dihedral angle will be used in defining wing
31	ITWIST	Foil I5	= 0	No wing twist considered
			≠ 0	Wing will be twisted
36	IVERT	Foil I5	= 0	Horizontal tail, wing, canard will be defined
			≠ 0	Vertical tail or pylon will be defined

F-2 WING DEFINITION CARD (7F10.0)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	CROOT	Foil F10.0	Root chord
11	CTIP	Foil F10.0	Tip chord
21	SWEEP	Foil F10.0	Leading edge sweep angle deg.

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
31	BOV2	Foil F10.0	Distance from root to tip (b/2)
41	CRXLE	Foil F10.0	X Location of root leading edge
51	CRYLE	Foil F10.0	Y Location of root leading edge
61	CRZLE	Foil F10.0	Z Location of root leading edge

F-3 DIHEDRAL DEFINITION CARD (7F10.0)(Read only if IDIHED>0)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	DANGLE	Foil F10.0	Dihedral angle in degrees
11	YD	Foil F10.0	Y location of rotation for dihedral
21	ZD	Foil F10.0	Z location of rotation for dihedral

F-4 TWIST DEFINITION CARD (7F10.0)(Read only if ITWIST 7D)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	TWIST(1)	Foil F10.0	Twist angle - Deg. for tip airfoil
11	TWIST(2)	Foil F10.0	Twist angle - deg at 2nd airfoil station
21	TWIST(3)		Rotation is about L.E of airfoil. Clockwise is positive (i.e trailing edge down).
etc			

Input 7 twist values per card NS values total. Last value is twist at root section.

F-5 X DEFINITION CARDS (7F10.0)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	XOC(I)*	Foil F10.0	X/C values used to define airfoil
11	etc.		

F-6 INBOARD AIRFOIL DEFINITION CARD (F10.1)(Input only if NFOILI 0)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	TYPEI	Foil F10.1	NACA Airfoil definition either 4 or 5 digit series, i.e. 0012, 2412, 64006, etc.

F-7 INBOARD AIRFOIL UPPER SURFACE DEFINITION CARD (7F10.0)(Input only if NFOILI>0)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	ZIU(I)*	Foil F10.0	Z/C value for root upper surface

F-8 INBOARD AIRFOIL LOWER SURFACE DEFINITION CARD (7F10.0)(Input only if NFOILI>0) and IVERT = 0)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	ZIL(I)*	Foil F10.0	Z/C value for root trailing surface

F-9 OUTBOARD AIRFOIL DEFINITION CARD (F10.1)(Input only if NFOILO = 0)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	TYPEO	Foil F10.1	Same explanation as for TYPE I

F-10 OUTBOARD AIRFOIL UPPER SURFACE DEFINITION CARD (F10.1) (Input only if NFOILO>0)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	ZOU(I)*	Foil F10.0	Z/C values for tip upper surface
11	Etc.		

F-11 OUTBOARD AIRFOIL, LOWER SURFACE, DEFINITION (F10.1) (Input only if NFOILO>0) and IVERT = 0)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	ZOL(I)*	Foil F10.0	Z/C values for tip lower surface

F-12 SPANWISE PANEL DEFINITION CARD (F10.1)(Input only if IND ≠ 0)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	ETA(2)	Foil F10.0	Location of spanwise sections to be defined ETA = y/b/2

*Input 7 values per card
NPTS total values

SUBROUTINE CONICS

CO-1 SOURCE PANEL CONTROL CARD (2I5) (Used on first case only)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	NTOT	CONICG I5	Number of source panels per N-line
6	ITRULE	CONICG I5	= 0 HESS format on output and tape = 1 Writes X(I), Y(I) and Z(I) on output and tape also = 0 input more cases ≠ 0 stop ITRULE input for 1st case only

CO-1' is the same as CO-1 except ITRULE is not included.

CO-2 TRANSLATION CARDS (3F10.0, 2A10) (Used on subsequent cases if NTOT ≤ 0 return)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	XOR	CONICS F10.0	X Value used to translate all coordinates
11	YOR	CONICS F10.0	Y Value used to translate all coordinates
21	ZOR	CONICS F10.0	Z Value used to translate all coordinates
31	SECID	CONICS F10.0	Section ID see HESS input for definition
41	XTRPRN	CONICS F10.0	Print flag used in HESS see HESS for details

CO-3 INITIAL POINT CARD (3F10.0 2A10)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	XE	CONICS F10.0	X coordinate for 1st point X_o, in figure Co-1
11	YE	CONICS F10.0	Y coordinate for 1st point Y_o in figure Co-1
21	ZE	CONICS F10.0	Z coordinate for 1st point Z_o in figure Co-1

CO-4 CURVE DEFINITION CARD (A1, A9, I5, 5X, F10.0, 3A10)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	NM1	CONICS A1	NMI = S Straight curve generated = C Conic generated
2	NM2	CONICS A9	Identifier used so that words straight and curve can be input rather than S and C used only for output.
11	N	CONICS I5	Number of equally spaced intervals on curve generated.
21	RHO	CONICS F10.0	Nondimensional distance of mid point from center of Conic, see figure Co-1 (input only if NM1 = C).
31 41 51	XC YC ZC	CONICS 3A10	These are center of Conic, input only if Conic does not lie in a primary plant or Conic is concave otherwise program will calculate.

CO-5 FINAL POINT CARD (3F10.5, I5)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	XE	CONICG F10.5	x coordinate for last point on conic (x_n in figure Co-1)
11	YE	CONICG F10.5	y coordinate for last point on conic (y_n in figure Co-1)
21	ZE	CONICG F10.5	z coordinate for last point on conic (z_n in figure Co-1)
31	NPARTS	CONIGG I5	number of parts conic is to be divided into. This value used only if it is desired to vary the point spacing over the conic or to output points over more or less than the full quadrant.

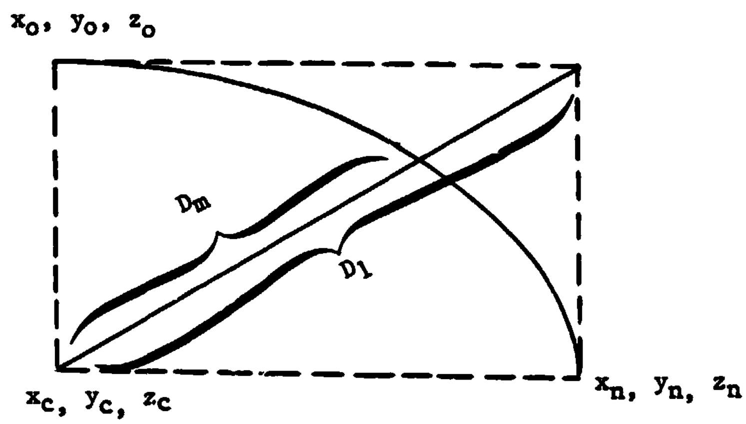
CO-6 CONIC DIVISION CONTROL CARD (2I5) (INPUT ONLY IF NPARTS>0)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	NJ	CONICG I5	The number of segments on part of the conic. NJ is input NPARTS times. The order of input is from 1st point to last (if data on only part of conic desired set NJ=0 on other part not desired).

CO-7 CONIC DIVISION VALUES (3F10.4, I5)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	XJ	CONICG F10.4	x value of END of segment of CONIC
11	YJ	CONICG F10.4	y value of end of segment of conic
21	ZJ	CONICG F10.4	z value of end of segment of conic

NPARTS number of these values input XJ, YJ, ZJ must progress on along conic line from first to last point (for part of conic not desired set starting and end points the same except for slight drift to prevent numerical bomboffs).



$$RHO = \frac{D_m}{D_l}$$

Figure CO-1

SUBROUTINE CIRCGN

This subroutine generates data for inlets - halfinlets - circle - half circle.

C-1 PROGRAM CONTROL CARD (2A4, A2, 3X, I2, 5X, 2A10)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	N1	CIRCGN A4	N1 = half do half circle or half inlet N1 = circ do circle N1 = inle do inlet N1 = END stops execution CIRCGN
5	N2	CIRCGN A4	used to complete definition of surface to consider if N1 = half then N2 =-INL do half inlet N2 =-CIR do half circle
9	N3	CIRCGN A2	used to complete definition of surface, used in output only
14	N	CIRCGN I2	input for circles and half circles only. The number of divisions of the angular location of pts ($\Delta\psi = \frac{2\pi}{N}$ (circles) $\Delta\psi = \frac{\pi}{N}$ half circles)
21	L1	CIRCGN A10	Section ID - Hess input - see hess for details
31	L2	CIRCGN A10	Print Flag - See HESS input for details

Note: N1 + N2 + N3 = inlet
half-inlet
circle
half-circle

These are only acceptable inputs to N1 N2 & NG

C2 CURVE DEFINITION CARD (4F10.0, A10)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	D	CIRCGN F10.0	Diameter of circle on inlet (input only if R=0)
11	R	CIRCGN F10.0	Radius of circle or inlet (input only if D=0)
21	PHIZ	CIRCGN F10.0	Initial value of angular position input for circles or half circles only
31	PHIF	CIRCGN F10.0	Final value of angular position input for circles or half circles only

C-3 CURVE ROTATION CARD (4F10.0, A10)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	XC	CIRCGN F10.0	x center of rotation
11	YC	CIRCGN F10.0	y center of rotation
21	ZC	CIRCGN F10.0	z center of rotation
31	ROT	CIRCGN F10.0	rotation about pitch axis about (x_c, y_c, z_c) degrees
41	NØENDFL	CIRCGN F10.0	if blank ENDFILE written on tape if nonblank no ENDFILE written
			when done with CIRCGN input N1 = end

SUBROUTINE HESPLT

Subroutine HESPLT generates CALCOMP plots of the hess input geometry. The HESPLT input consists of all of the hess input plus some viewing angle input data. Therefore we will only show the extra data required here and will return the user to the hess input section for the main body of input data.

HESS DATA INPUT (See hess input)

Following HESS input the following card or cards are added

HP-1 VIEWING ANGLE CONTROL CARDS (4F10,3,20X,2A10)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	ALPHA	HESPLT	pitch angle at desired view deg (+ left hand rule) if ALPHA input greater than 360° then program terminates. Use this option to END DATA input.
11	BETA	HESPLT F10.3	ΦAW angle of desired view (POS according to right hand rule)
21	PHI	HESPLT F10.3	Roll angle at desired view (positive according to left hand rule)
31	SKALE	HESPLT F10.3	Plot scale If scale = 0 the routine will determine the proper scale.
61	VW(1)	HESPLT A10	to character alpha numeric array describing view (i.e. top view)
71	VW(2)	HESPLT A10	

Input as many of the viewing angles as desired at this point stopping input with a value >360 in the alpha input array.

SUBROUTINE JUNC PAN

This routine finds the juncture between a nonlifting HESS section (fuselage, nacelle) and a lifting section (wing, horizontal, vertical). The input consists of coordinate data set up for hess input. The data required is listed below. For details on the proper order of data see the HESS input module.

TITLE CARD (8A10)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	TITLE(I)	JUNC 8A10	Title of case

NON LIFTING SECTION CONTROL CARD (16I5)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	NLSTR	JUNC I5	Number of non-lifting strips in non-lifting section
6	NLSØR	JUNC I5	Number of panels per strip in non lifting section

LIFTING SECTION CONTROL CARD (16I5)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	NSTRIP	JUNC I5	Number of lifting strips in lifting section
6	NSØRCE	JUNC I5	Number of panels per strip in lifting section
11	NWAKE	JUNC I5	Number of wake panels per strip in lifting section

NON LIFTING SECTION INPUT CARDS (T61,A10,T1,(6F10.4))

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	XNL(I)	JUNC F10.4	x coordinates on 1st N line of non lifting section
11	YNL(I)	JUNC F10.4	y coordinate on 1st N line of non-lifting section
21	ZNL(I) ZNL(I)	JUNC F10.4	z coordinate on 1st N line of non-lifting section

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
31	XNL(I+)	JUNC F10.4	
41	YNL(I+1)	JUNC F10.4	
51	ZNL(I+1)	JUNC F10.4	
61	SECIDNL	JUNC A10	Section identifier

z sets of XNL, YNL, ZNL per card input NLSØR+1 values

NON-LIFTING SECTION INPUT CARDS (6F10.4)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	XNL(I)	JUNC F10.4	x coordinate on N line of non lifting coordinates
11	YNL(I)	JUNC F10.4	y corresponding to x above
21	ZNL(I)	JUNK F10.4	z corresponding to x above
31	XNL(I)	JUNK F10.4	

etc

Input 2 sets of XNL, YNL, ZNL per card.
Input NLSDR+1 values.
Repeat these cards for all N lines in this section (I=2, NLSTR+1).

LIFTING SECTION INPUT CARDS (T61,A10,T1, (6F10.4))

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	XL(I)	JUNC F10.4	x coordinate on 1st N-line of lifting section.
11	YL(I)	JUNC F10.4	y coordinate of 1st N-line of lifting section
21	ZL(I)	JUNC F10.4	z coordinate of 1st N-line of lifting section

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
31	XL(I+)	JUNC F10.4	
41	YL(I+1)	JUNC F10.4	
51	ZL(I+1)		
61	SECIDL	JUNC A10	Lifting Section Identical

Input 2 sets of XL, YL, ZL per card
Input NSORCE + NWAKE+1 values

LIFTING SECTION INPUT CARDS (6F10.4)

COLUMN	CODE	ROUTINE FORMAT	EXPLANATION
1	XL(I)	JUNC F10.4	x coordinate on Nline of lifting section
11	YL(I)	JUNC F10.4	y coordinate on N line of lifting section
21	ZL(I)	JUNC F10.4	z coordinate on N line of lifting section
31	XL(I)	JUNC F10.4	x coordinate on N line of lifting section

Input 2 sets of XL, YL, ZL per card.
Input NSORCE + NWAKE +1 values for each N line.
Repeat input NSTRIP + 1 times.

APPENDIX B - INTERACTIVE GRAPHICS INPUT PROGRAM (HESTEK)

The input geometry required by the Hess three-dimensional program must be developed carefully in order to adequately describe the configuration being analyzed. Most aircraft configurations are complex and thus require a considerable manhour expenditure to develop an appropriate model. For example, the modeling of a typical V/STOL configuration, without using any of the input routines discussed in this report, could take two to four weeks of concentrated effort. Even using the routines in this report, considerable effort is still required and the possibility of mistakes in the geometry is high due to the large number of coordinates involved. Therefore in order to reduce both the model development time and the possibility of errors, a stand alone interactive graphics program was developed. This program permits the user to display all or part of the model developed and to make corrections where necessary. The program has the capability of moving points, lines or sections, adding or deleting lines and deleting sections. Note that individual points may only be moved, they can not be added or deleted.

The following discussion describes the operation of this program.

PROGRAM DISPLAY CAPABILITIES

When program HESTEK is accessed, a graphical representation, Figure B-1, will appear on the screen. The current values of scale factor and pitch, roll and yaw angles will be displayed. This graphical display can be altered in several ways as explained below.

A) PLOT SCALING

The size of the graph being displayed can be changed in several ways.

(1) The size can be increased by a factor of 2 by pressing the (>) (greater than) key. The display will erase and be replotted twice the original size. This process can be repeated as many times as desired.

(2) The size can be decreased by a factor of 2 by pressing the (<) (less than) key. The display will erase and be replotted at one-half the original size. This process can be repeated.

(3) The scale parameter can be changed to whatever the user desires by pressing the (I) key. The program will then respond with a request and the scale desired can be input.

B) PLOT POSITION

In the process of scaling, it sometimes becomes necessary to reposition the viewing window so that a particular region of the configuration is at the center. This is accomplished by moving the cross hairs to the point on the current graph that is desired

to be in the center. The (=) (equal) sign key is now depressed which will cause the graph to be replotted at the same scale with this new position in the center of the graph.

C) CONTENTS OF DISPLAY

The contents of the display may also be altered. It may be desired to only view one section or possibly a group of sections alone. This can be done by hitting the (S) key. The program will respond by asking what section or sections are desired. The sections are selected either by section number, section ID, or section type, (i.e., all non-lifting sections may be plotted) (Figure B-2).

PROGRAM MODIFICATION CAPABILITIES

Once a graphical representation of the model is available, it sometimes becomes desirable to modify the model by: (1) moving points, lines, or even sections, (2) adding or deleting a strip-line or panel-line, and (3) deleting a section. The programs contain several options as described below for performing these tasks.

A) MOVING A POINT, LINE OR SECTION

Either an individual point, a particular line or an entire section may be moved as explained below.

(1) MOVEMENT OF A POINT

Position the crosshairs on the point to be moved and depress the (.) (period) key. A slash will then be placed on this point for identification. Then move the cursur crosshairs to the position desired and depress the (@) key. The plot will be redrawn with the point moved.

(2) MOVEMENT OF A LINE

If an entire line is to be moved, a similar procedure is followed. Position the cursur crosshairs over one point in the line, at an intersection point, and depress the (L) key. Then, in order to identify the line, move to another point on the line and again depress the (L) key. Note, if desired several points on the line may be chosen as above. Then, position the cursur crosshairs where it is desired to move the first point on the line, and depress the (@) key. The entire line will then be moved to this new location. This procedure works on either a strip-line or a panel-line.

(3) MOVEMENT OF A SECTION

An entire section may be repositioned if desired, by placing the cursur crosshairs at a control point selected within the section and depressing the (T) key. This control point must be a point for which the transformed location is known. Then

move the cursurs to the location where the control point is to be transformed and depress the (@) key. The plot will be redrawn with the section containing the control point moved to the new location.

B) ADDING A LINE

A line may be added to a configuration by the following procedure: (1) position the cursur at a point where a line is desired and depress the (.) (period) or (L) key. Then move the cursur to another point where the line is pass through and depress the (+) key. A line will then be formed from the existing data by interpolation which passes through the two points chosen above.

C) DELETING A LINE OR SECTION

A line or section may be deleted as explained below

(1) DELETING A LINE

Place the cursur on one point in the line and press the (.) (period) or (L) key. Then move the cursur to another point on the line and depress the (-) key. This will remove that line from the section.

(2) DELETING A SECTION

Place the cursur on a point in a section and depress the (T) key. Then depress (-) key to delete section.

PROGRAM EDITING CAPABILITIES

The data set from which the plots are drawn may be edited as explained below. The data set can be viewed by depressing the (E) key. This causes the data set to be printed on the screen one page at a time. The following procedure is used to modify values in the data set.

(1) CHANGING AN ENTRY

To change a value in the data set, move the cursur to the value in question and depress the (C) key and then enter the new value. This is repeated as needed.

(2) VERIFICATION OF CHANGES

After making changes, depress the (V) key, this will cause the same page to be rewritten with the changes incorporated.

(3) LISTING OF DATA

After a change in made or after a page has been reviewed, depress the (g) key to continue listing data.

(4) SKIPPING DATA

If it is desired to skip parts of a section, simply depress the (N) key. This will cause the program to skip to the next data section.

(5) EXITING FROM EDIT MODE

Depressing the (:) (cclon) key causes the program to return to the program mode.

There are several other operations which may be performed when operating this program. These operations are discussed below. In addition, the location of the modified data files are discussed.

(1) At any time in the modification of a data set, the current data may be saved by depressing the (C) key. This creates a file called CHKDAT. Everytime the (C) key is pressed, the file is rewritten.

(2) If mistakes are made in a change and it is desired to return to the previous data set, simply depress the (N) key. This deletes the current change.

(3) If it is desired to return to the original data set depress the (O) key.

(4) If it is desired to view the file saved or the CHKDAT file, depress the (R) key.

Finally, when all modifications and operations are finished, depress the (B) key. This terminates the program. At termination, three files are available: (1) the original data file is available under the input file name and tape 5; (2) the CHKDAT file is available and (3) the final file which was being worked on at termination is stored on the NEWDAT file. Note tht by proper use of the CHKDAT file, it is possible to create two files which contain different modifications to the same configuration.

SCALE = 1.0
PITCH = 0.0
YAW = 0.0
ROLL = 90.0

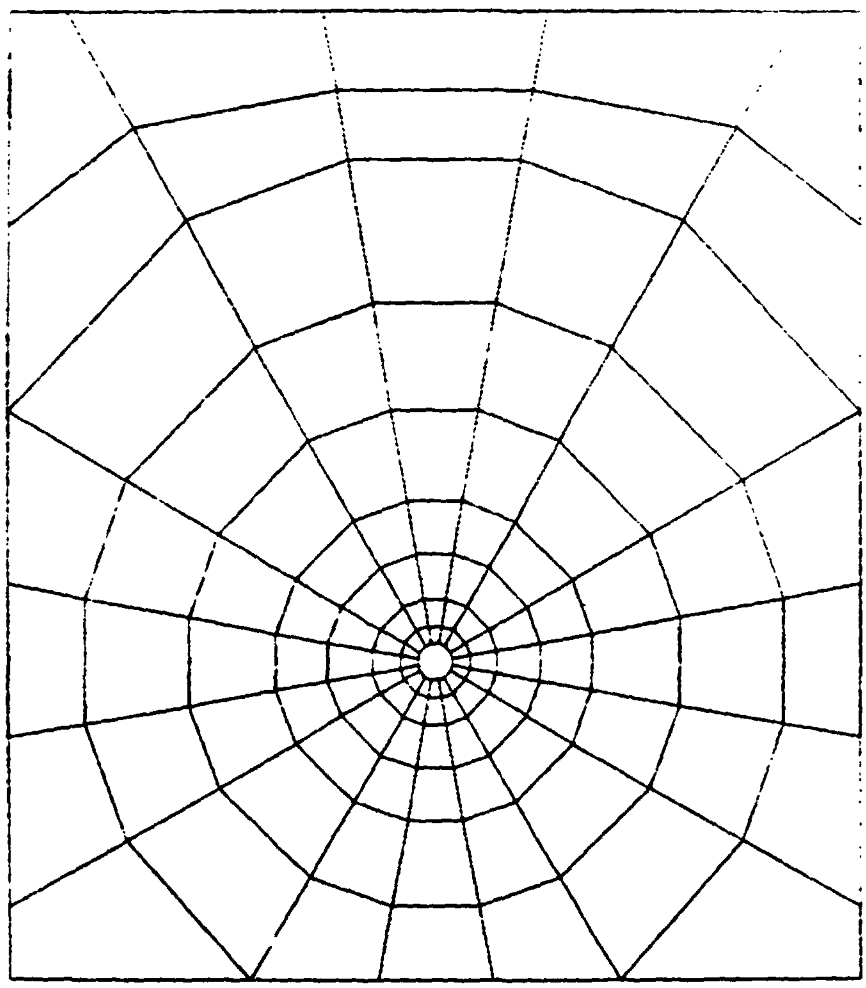


Figure B-1. Original Plot placed on screen

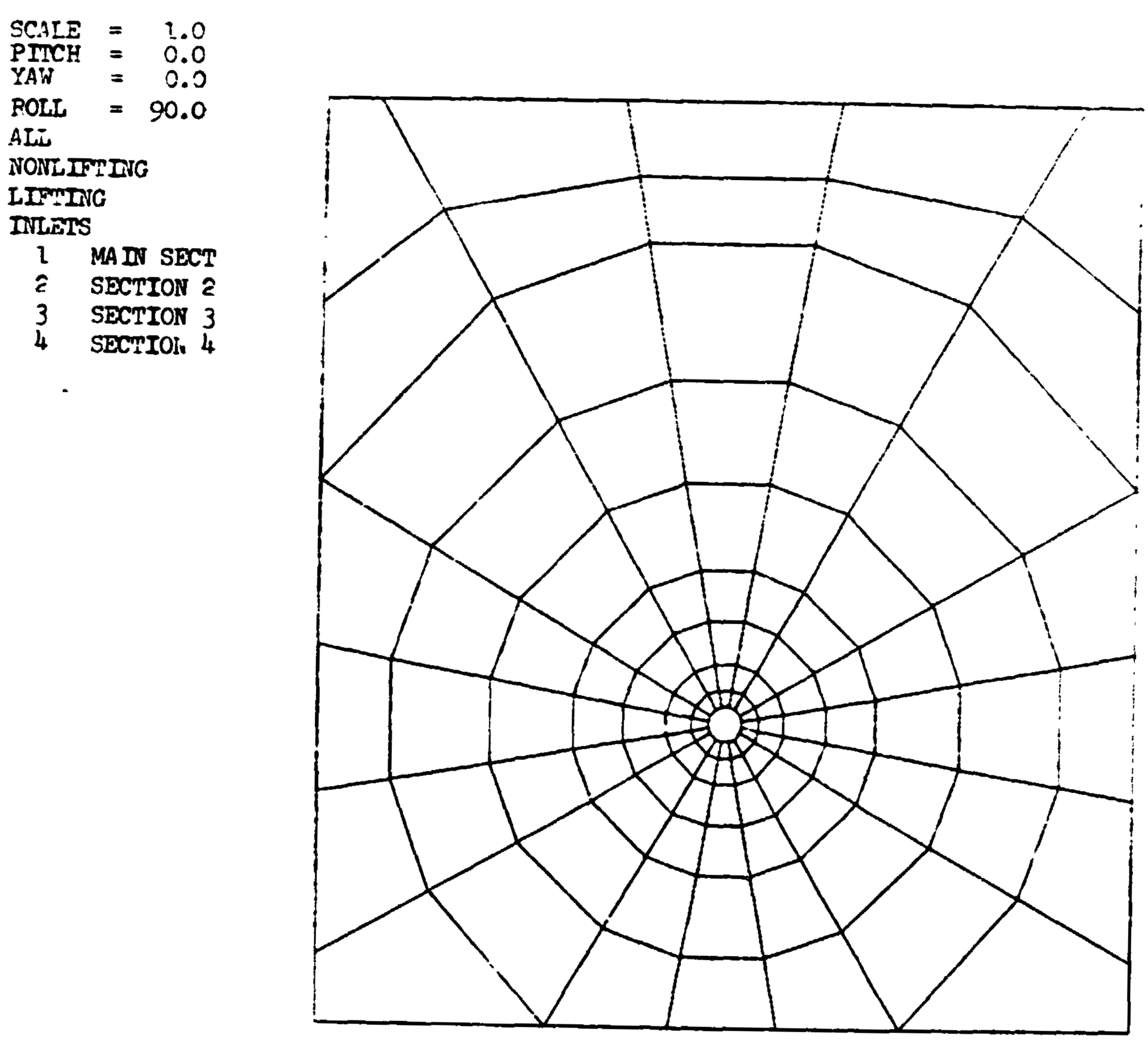


Figure B-2. Plot displayed when (S) Key Depressed